DIV. OF HERPETOLOGY

1952, No. 3 September 26

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THE SHERMAN C. BISHOP MEMORIAL NUMBER

PUBLISHED BY

THE AMERICAN SOCIETY OF

ICHTHYOLOGISTS AND HERPETOLOGISTS

CONTENTS

SHERMAN C. BISHOP, 1887–1951. By *Arnold B. Grobman* 127
THE VENOM APPARATUS OF THE RATFISH, *Hydrolagus colliei*. By *Bruce W. Halstead* and *Norman C. Bunker* 128
NOTES ON THE SCORPAENID FISHES OF WASHINGTON AND ADJACENT AREAS, WITH A KEY FOR THEIR IDENTIFICATION. By *Dayton L. Alverson* and *Arthur D. Welander* 138
FOOD OF THE STRIPED MARLIN, *Makaira mitsukurii*, FROM NEW ZEALAND. By *James E. Morrow* 143
AN ACCESSORY RESPIRATORY DEVICE IN EMBRYOS OF THE EMBIOTOCID FISH, *Cymatogaster aggregata*, DURING GESTATION. By *C. L. Turner* 146
OBSERVATIONS ON CHILL TOLERANCE AND APPLIED CHILL COMA IN SUBTROPICAL AMERICAN MARINE FISHES, ESPECIALLY *Bathygobius*. By *E. F. B. Fries* 147
PATTERN VARIATION AND EVOLUTION OF THE MOUNTAIN KINGSNAKE, *Lampropeltis zonata*. By *Richard G. Zweifel* 152
THE FOOD OF THE NIGHTLIZARDS, GENUS *Zantusia*. By *Bayard H. Brattstrom* 168
THE MOUTH PARTS OF TADPOLES OF THE SPADEFOOT TOAD, *Scaphiopus hammondi*. By *Frederick B. Turner* 172
A NEW TOAD FROM THE HIGHLANDS OF GUATEMALA AND CHIAPAS. By *Philip W. Smith* 175
CLIMATIC FACTORS INFLUENCING THE BREEDING MIGRATION OF THE SPOTTED SALAMANDER, *Ambystoma maculatum* (SHAW). By *Richard J. Baldauf* 178

HERPETOLOGICAL NOTES

A concentration of juvenile spotted salamanders, *Ambystoma maculatum* (Shaw). By *Jerry D. Hardy, Jr.* 181
The correct generic names for the iguanid lizards of Madagascar and the Fiji Islands. By *Jay M. Savage* 182
The distribution of the Pacific giant salamander, *Dicamptodon ensatus*, east of the Cascade Mountains. By *Jay M. Savage* 183
Notes on breeding and reproduction in the lizard *Anolis carolinensis*. By *George W. D. Hamlett* 183
Observations on cricketfrog locomotion. By *Robert G. Hudson* 185
Notes on the Latin American skink, *Mabuya mabouya*. By *W. Leslie Burger* 185
Sexual and growth changes in the pattern of the gecko *Sphaerodactylus difficilis* Barbour. By *Chapman Grant* 187
The crowned snake, *Tantilla coronata coronata*, in North Carolina. By *Jerry Hardy, Jr.* 188
Some commensal relations of the lizard *Cnemidophorus sexlineatus* (Linne). By *Paul G. Pearson* and *Gid E. Nelson, Jr.* 189
The southern range of the racer *Coluber constrictor stejnegerianus* (Cope), with remarks on the Guatemalan species *Coluber ortenburgeri* Stuart. By *Richard E. Etheridge* 189
A new size record for the eastern gartersnake, *Thamnophis sirtalis sirtalis* (Linnaeus). By *A. J. Barton* 190
Variation in the greensnake, *Opheodrys vernalis* (Harlan), from the Black Hills, South Dakota. By *C. Richard Robbins* 191
Notes on the spadefoot toad *Scaphiopus h. holbrooki*. By *Roger W. Barbour* and *William L. Gault* 192
Neoteny and the urogenital system in the salamander *Dicamptodon ensatus* (Eschscholtz). By *Michael N. De Marco* 192
A large bullsnake, *Pituophis catenifer sayi*, from Texas. By *James R. Dixon* 193
Watersnake killed by horned pout. By *Richard Stafford* 193
The coal skink, *Eumeces anthracinus* (Baird), in Maryland. By *Leo Lemay* and *Anthony G. Marsiglia* 193
The belltoad, *Ascaphus truei*, in Mendocino County, California. By *George W. Salt* 193
New records of *Rana virgatipes* and *Rana grylio* in Georgia and South Carolina. By *Wilfred T. Neill* 194
Remarks on salamander voices. By *Wilfred T. Neill* 195
Burrowing habits of *Hyla gratiosa*. By *Wilfred T. Neill* 196

ICHTHYOLOGICAL NOTES

Egg counts of *Salvelinus malma* from the Clark's Fork River, Montana. By *Royal Bruce Brunson* 196
Spawning of the dolly varden, *Salvelinus malma*, in Twin Creek, Idaho. By *Paul R. Needham* and *Tim M. Vaughan* 197
Greenland cod (*Gadus ogac*) in Miramichi Bay, New Brunswick. By *R. A. McKenzie* 199
A new record of the pointed-tailed ocean sunfish, *Masturus lanceolatus*, from North Carolina. By *John B. Funderburg* and *Theodore H. Eaton, Jr.* 200
Establishment of white perch, *Morone americana*, in central New York. By *W. A. Dence* 200
On the distribution and habits of the wattled eel-pout, *Lycodes palearis*. By *J. W. Slipp* and *A. C. DeLacy* 201
A new name for the Peruvian parrotfish, *Scarus dubius* Hildebrand preoccupied by *S. dubius* Bennett. By *Roberi H. Kanazawa* 203
An observation of "flight" in the pompano. By *Craig Phillips* 203
Records of the western lake chubsucker, *Erimyzon sucetta kennerleyi*, from Ontario, Canada. By *W. B. Scott* 203
A method of marking larval lampreys. By *Roland L. Wigley* 203
Additional records of freshwater fishes from Texas. By *E. W. Bonn* and *Robert J. Kemp* 204
Notes on Gulf of Maine fishes in 1950 and 1951. By *Leslie W. Scattergood* 205
Systematic notes on the oceanic fishes of the genus *Lophotus*. By *John C. Briggs* 206
Tri-sodium phosphate as a storage medium for otoliths. By *C. Richard Robins* and *Richard H. Backus* 207
First record of the dolly varden, *Salvelinus malma*, from Nevada. By *Robert Rush Miller* and *Wm. Markham Morton* 207
Observations of age and growth in the menhaden (*Brevoortia tyrannus*) as determined by scale examination. By *William A. Rush* 208
Three species of fishes, genus *Seriola*, in the waters of Cape Cod and vicinity. By *Frank J. Mather III* 209
A northern record of the white crappie from Lake Huron, Ontario, Canada. By *J. C. Budd* 210
An "unusual" yellowfin tuna (*Neothunnus macropterus*) from the waters of the northern Line Islands in the central Pacific Ocean. By *Fred C. June* 210

REVIEWS AND COMMENTS—Handbook of turtles; by Archie Carr, *by Norman Hartweg:* 212.—Schöne fischbücher; kurze geschichte der ichthyologisches illustration; bibliographie fischkundlicher abbildungswerke; by Claus Nissen, *by Romeo Mansueti:* 212.—The fishes of the Indo-Australian Archipelago. IX Percomorphi (concluded), Blennioidea; by L. F. de Beaufort, *by Leonard P. Schultz:* 213.—Meristic variations and populations of northern anchovy (*Engraulis mordax mordax*); by J. L. McHugh: 213.—The food of albacore (*Germo alalunga*) off California and Baja California; by J. L. McHugh: 214.—Billy Bass. Tommy Trout. Bobby Bluegill. Three bulletins by R. W. Eschmeyer: 214.—Some principles of marine fishery biology; by Martin D. Burkenroad: 214.

EDITORIAL NOTES AND NEWS—Summary of the 1952 meetings, *by Edward C. Raney:* 214.—Meeting of Western Division: 220.—Sociedad Mexicana de Hidrobiologia: 221.—Financial contributions: 221.—Revolving research fund: 221.—A new journal: 221.—Committee on common names: 221.—News notes: 221.—Correction: 222.—Board of Governors of the ASIH: 222.

Published quarterly at Mt. Royal & Guilford Aves., Baltimore 2, Md. by the American Society of Ichthyologists and Herpetologists, the Museum of Zoology, University of Michigan, Ann Arbor, Michigan. Entered as second class matter at the Post Office at Baltimore, Md. under the Act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized February 11, 1924.

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... 152
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SHERMAN C. BISHOP

1887–1951

1952, No. 3 COPEIA September 26

SHERMAN C. BISHOP

1887–1951

SHERMAN C. BISHOP was born on November 18, 1887 in Sloatsburg, New York. His family—his very religious father and his resourceful mother and sister—soon took him to Clyde, New York, where he spent most of his childhood. Here, on the banks of the Erie Canal, not far from the beautiful Finger Lakes country, he had his first contacts with natural history. Here, also, his independence of spirit led him into so much conflict with local school authorities that he felt it best to leave high school before graduating. A sympathetic teacher, Elmer J. Bond, impressed with the young man's knowledge and interest in natural history, encouraged and aided him to enter Cornell University as a special student in entomology.

Here he found himself. He completed the work for the bachelor's degree (including his unfinished secondary school work) and began advanced work in zoology. About four years later, in 1917, shortly before enlisting in the Navy, he married Alice Stoddard who, with their daughter, Mrs. Beth Odell, survives him. His naval service during World War I was spent mostly at the Charleston Naval Base where he worked in Naval Intelligence. Before completing his advanced work, he accepted the position of State Zoologist at the New York State Museum, Albany, where he remained from 1916 to 1928. In 1925 he received his doctor's degree from Cornell, based, in part, upon a problem in arachnology. In 1928 he became associated with the Department of Zoology of the University of Rochester. This association continued until he died, after a lengthy illness, on May 28, 1951.

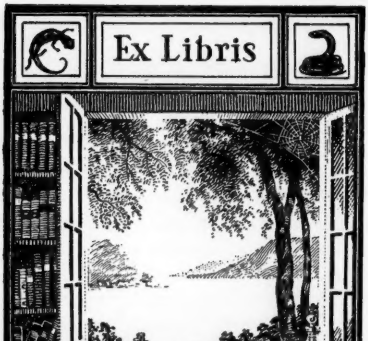
His published contributions in herpetology and arachnology form a substantial monument to his career. Although he is probably best known for his many excellent and carefully-done papers on salamanders, he published, frequently in conjunction with Professor C. R. Crosby, about one hundred papers on spiders. He also published on fishes, birds, mammals, toads and turtles. Herpetologists know him particularly for two outstanding works. His "The Salamanders of New York," 1941, is probably the most complete report on a group of animals from a state ever assembled.

A far greater contribution, both in its coverage and effectiveness, is his "Handbook of Salamanders," 1943. This is the first serious and comprehensive treatment of North American salamanders since Cope (1889) and has served not only to assemble all available information about Canadian and United States salamanders, but has been the direct stimulus for further work by many other investigators. The maps, particularly, in addition to being a very important compilation, have been very stimulating in encouraging further geographic studies on salamanders. The "Handbook" serves well as a model for other herpetological handbooks—some since completed and some still projected.

He was a successful undergraduate instructor, but he was especially effective with his advanced students. His scholarly grasp of the literature and the excellence of his laboratory and field work served as stimulating examples for his graduate students. These were in the main left to their own devices, with few suggestions or comments directly proffered by Dr. Bishop. Because of this informal yet rigorous guidance, many of his students developed into competent, effective, and independent workers.

No statement about Dr. Bishop would be complete without mention of his overwhelming generosity to his students and colleagues. His virtually complete file on salamander distribution and literature (he offered cash awards for each reference to a paper with information on American salamanders not already in his files) was open to all students as were also his superlative personal collections of salamanders and spiders. He was appreciative of good craftsmanship—whether executed by an artist or a mechanic.

For more than the last ten years he had been seriously and painfully ill. His remarkably



excellent spirits and earthy humor had, therefore, an almost inspirational effect on his colleagues. Dr. Bishop had an unusually large circle of close friends by whom he was extremely well liked. The number of his more casual acquaintances was small, in association with his retiring nature and his reticence when in the company of comparative strangers. Something of Sherman Bishop's love of science and of nature and of his native Finger Lakes Region was caught by his friend, H. P. Crisp, for his attractive book plate.

Herpetologists will grieve over the loss of an outstanding specialist on the salamander group. He was a charter member of the American Society of Ichthyologists and Herpetologists. The greater loss is that of a real naturalist in the best tradition. Dr. Bishop knew the flowers and trees; he knew the insects and arachnids; he knew the fishes and the reptiles; he knew the amphibians.

He not only knew what kinds there were and how each kind lived, but he also appreciated how they lived with each other. He was a great naturalist. There are very few left. In the death of Sherman Bishop we have suffered a great loss.—ARNOLD B. GROBMAN, *Department of Biology, University of Florida, Gainesville, Florida.*

The Venom Apparatus of the Ratfish, *Hydrolagus colliei*[1]

BRUCE W. HALSTEAD AND NORMAN C. BUNKER

A SURVEY of the literature dealing with medical ichthyology indicates that Bottard (1889: 175) was one of the first to suggest the possibility that the dorsal spine of the chimaera acts as a venom apparatus. However, in his studies on *Chimaera monstrosa* Linnaeus, he was unable to locate what he considered to be a venom organ. Later, Evans (1923: 16–17, 29; 1943: 115–118; 1944: 860) obtained two specimens of *C. monstrosa*, one from Lousy Bank in the North Sea, and the other from the Mediterranean Sea. By preparing histological sections of the dorsal spines of these fish, he was able to demonstrate a layer of glandular epithelium lying in the posterior groove of the dorsal spine. It was his opinion that this glandular tissue represented a true venom organ. Unfortunately, Evans did not have ready access to fresh material and was unable to complete his investigations. During the course of our research on poisonous and venomous fishes, we became interested in this problem and decided to conduct some studies on the dorsal spine of the Pacific ratfish, *Hydrolagus colliei* (Lay and Bennett), which is closely related to *C. monstrosa*. A thorough search through the literature failed to reveal any additional references dealing with the microscopic anatomy of the dorsal spines of the Chimaeridae.

Hydrolagus colliei (see Dean, 1906: Pl. XI, p. 194) is the only chimaera recorded on the Pacific Coast of North America. Its known range extends from Alaska southward to

[1] This investigation was aided in part by a grant from the National Institutes of Health, Public Health Service, and a contract from the Office of Naval Research.

southern California. According to Walford (1935: 63) the ratfish is not common south of Monterey Bay. The vertical distribution of this species differs from most other chimaeroids. Goode and Bean (1895: 32) stated that the ratfish may be seen swimming at the surface of the water in southeastern Alaska and British Columbia, but generally inhabits deeper water southward. The usual depth range is given as five to 60 fathoms, while most other chimaeroids inhabit depths of 100 to 1300 fathoms, or more.

The Pacific ratfish tends to be omnivorous in its eating habits; however, the bulk of its diet consists of molluscs and a wide variety of crustaceans. *Hydrolagus colliei* is readily taken by hook on hand lines or setlines. Squid or octopus are excellent bait. This species attains a length of about three feet.

Medical Significance of Chimaeroids.—Dean (1906: 16) expressed the opinion that fishermen fear the jaws of the ratfish more than they do the formidable dorsal spine. He mentioned one case in which a ratfish bit a piece of flesh from the hand of a fisherman. The venomous properties of the dorsal spine are briefly mentioned by Phisalix (1922: 515), in her reference to Richter (original reference not given), who claims that there is a chimaera that is feared by the Spanish fishermen and that a wound from the dorsal spine of this fish may produce death. Evans (1943: 116) stated that a sting from the spine of *Chimaera affinis* (Capello), which ranges from Cape Cod to Portugal, may have serious effects. Phisalix (1922: 581, 586) also stated that *Chimaera monstrosa* has poisonous flesh and that even though Lacépède claimed the Norwegians commonly eat the liver and roe without ill effects, abstention is recommended. In Smith's (1950: 76) discussion of the chimaeras he stated that their flesh is wholesome, but most people recoil from eating such repulsive looking fishes.

It is apparent that there is considerable confusion regarding the toxic nature of these fishes, and there is still need for further study of the matter. We have been unable to obtain any reliable case histories of wounds produced by *Hydrolagus colliei*, even though such have undoubtedly occurred. Some of the scrap fishermen of the Puget Sound area have informed us that the ratfish is handled with respect, but they did not indicate having any special fear of the spines.

Gross Anatomy of the Dorsal Spine

The specimens of *Hydrolagus colliei* used in the anatomical section of this paper were taken by trawling at 50 fathoms off Roberts Point, Blaine, Washington. As a basis for the description of the gross anatomy 21 spines were examined, most of them taken from young fish but several from adult specimens. The fish ranged from 178 to 716 mm. in total length, while the spines were from 28.6 to 104.2 mm. long. The length of the spines, measured from the point of origin at the body to the apex, averaged 6.9 in the total length. The shortest spine was 8.4, the longest one 4.0 in the total length; two-thirds of the spines did not deviate more than 0.5 from the mean. There was no clear indication of any change in the proportional length of the spine with advancing age.

The spines of young and adult fish, insofar as we are able to determine, are identical in appearance, so there is little need for a comparative description. The spines are described in the upright position.

The mature spine is elongate, tapers to an acute point and is composed of a cartilaginous core covered by a sheath of vasodentine. This structure is generally considered to be a modified denticle (Goodrich, 1909: 168). A lateral view of the spine reveals that it curves gracefully backward with the bend becoming slightly more marked in the terminal one-fifth (Fig. 1). The anterior margin of the spine is keeled and entire, while the two posterolateral margins are serrate, with the teeth pointing in a downward direction. The anterior keel of the spine is translucent and colorless, while the remainder is dark brown except for light areas where the pigment layer has been worn away. The anterolateral surface of the spine is marked by a number of fine ridges which diminish in size as they approach the posterior margin.

In cross section (Fig. 4) the spine is roughly trigonal in outline with a pronounced anterior keel and a shallow posterior depression, termed the interdentate depression. Lying within this depression is a strip of soft, greyish, sparsely pigmented tissue. Running in a vertical direction along the midline of this tissue is a dark

line which marks the junction where the spine was formerly connected with the dorsal fin. In most of our specimens the dorsal spine is connected with the anterior margin of the dorsal fin only at the proximal one-half of the spine, the terminal portion having been torn away. The remaining connecting membrane between the dorsal spine and fin is thickened and glistening white in appearance. Careful examination of this area fails to reveal the deep grooves

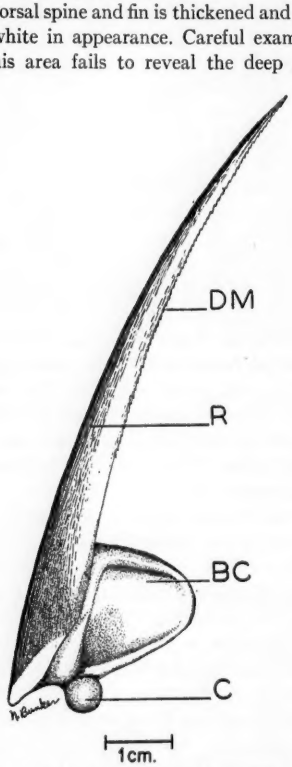


Fig. 1. Lateral view of spine. DM, dentate margin; R, ridges; BC, basal cartilage; C, condyle.

which Evans (1923: 17) observed in *Chimaera monstrosa*. However, when the dorsal fin is depressed and the spine is resting against the fin, the connecting membrane forms a fold which covers most of the dentate margin of the proximal one-half of the spine. Judging from the anatomical evidence available, it appears that this membrane is an integral part of the venom apparatus of the dorsal spine. Apparently one of the functions of this membrane is to bathe the dentate margins of the spine with secretions.

The base of the dorsal spine is situated directly above the origin of the pectoral fin. If the flesh at the base of the spine is dissected away, it will be seen that the spine is comprised of two portions, a hard dentinal part—which extends for almost the entire length of the spine—and a short basal portion which is composed of cartilage. Further observation reveals that the vasodentine portion is only an outer sheath enveloping an inner core of cartilage. This core is an elongate, superior extension of the cartilaginous base of the spine which extends up into the sheath for approximately ⅘ of its total length. These anatomical relationships can best be demonstrated by drying the spine. In the dried state, the dentinal sheath can be lifted off from the rest of the spine, thus exposing the core.

It will now be observed that the cartilaginous portion of the spine is comprised of three parts: an elongated superior extension, or inner core, the articulating base, and a posterior wedge-shaped projection. Since the superior extension was described in the previous paragraph, it will need no further discussion. Continuing to view the spine from the side, it will be noted that the articulating basal portion is further subdivided by a transverse notch into an anterior V-shaped process and a posterior condyle (Figs. 1, 2). Immediately above the condyle, and arising from the posterior aspect of the shaft of the core, is a greatly expanded, compressed, wedge-shaped piece of cartilage—the basal supporting cartilage for the dorsal fin. The basal cartilage serves as an attachment for the insertion of the depressor muscles of the spine, and a portion of the abductor muscles for the dorsal fin rays (Fig. 3).

The dorsal spine is supported by a highly modified, cartilaginous, neural spine of the anterior portion of the spinal column (Fig. 2). The neural spine is greatly elevated and strongly compressed medially to form a moderately expanded anterior process and a broadly expanded, wing-like, posterior process. These two processes are separated above by a deep notch. The posterior side of the posterior neural process is depressed so as to form a fossa of moderate depth. The fossa is subdivided into two lateral depressions by a low, vertical median ridge. The depressor muscles of the dorsal spine, one on each side, have their

origin in these lateral depressions. Situated on the dorsum of the posterior neural process is the fossa in which the condyle of the dorsal spine articulates.

There are six muscles, bilaterally distributed, which control the movements of the dorsal fin and spine (Fig. 3). These muscles consist of a pair of erectors, a pair of depressors, and a pair of abductors. The erector muscle has its origin in the depression between the anterior and posterior neural processes. This wedge-shaped muscle passes upward and backward

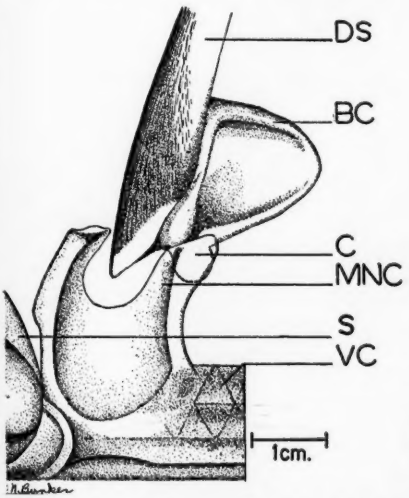


Fig. 2. Lateral view of articulation of dorsal spine with vertebral column. DS, dorsal spine; BC, basal cartilage; C, condyle; MNC, modified neural cartilage; S, skull; VC, vertebral column.

over the anterior and dorsal surface of the posterior neural process and inserts obliquely along the basal ⅓ of the dorsal spine. The function of the erector muscle, as the term indicates, is to erect the dorsal spine and aid the abductor muscle in spreading it. The depressor muscle has its origin in the posterolateral depression of the posterior neural process and inserts on the inferoposterior margin of the basal cartilage of the dorsal spine. Its function is to depress this spine. The abductor originates on the dorsum of the posterior neural process just lateral to the articular fossa and from the side of the basal cartilage. The muscle extends upward and, fanning out in a posterior direction, inserts by a number of small slips to the base of each of the dorsal fin rays. The function of this muscle is to spread or abduct the dorsal fin rays. In the use of the term abduction, the dorsal spine is used as the axis or point of reference. When in the depressed position, the dorsal fin rests in a longitudinal groove along the back. When referring to this depression, the term "dorsal fin groove" will be used.

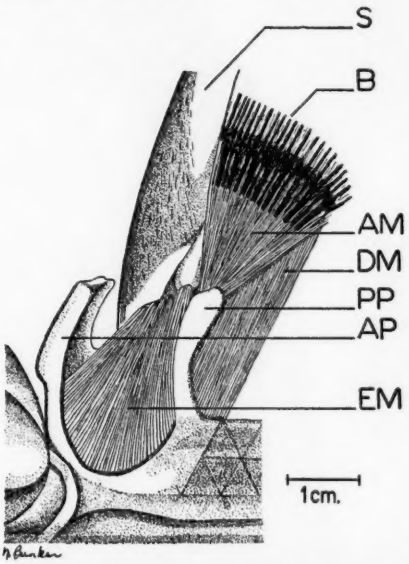


Fig. 3. Lateral view of base of dorsal spine showing origins and insertions of muscles. S, spine; B, base of dorsal fin; AM, abductor muscle; DM, depressor muscle; PP, posterior process; AP, anterior process; EM, erector muscle.

Microscopic Anatomy of the Dorsal Spine

The anterior angle of the spine is more acute than the two posterior angles and is heavily keeled (Fig. 4). The anterolateral surfaces are convex and marked by a number of grooves. The posterior side is slightly indented to form the broad, shallow interdentate depression. Cross sections of the marginal serrations can be seen at the posterolateral angles. The serrated portion of the spine is designated as the "dentate margin." This general configuration will be observed throughout most of the sections taken from the distal ¾ of the spine. As one approaches the basal ¼, the anterior angle becomes obtuse and the posterior side of

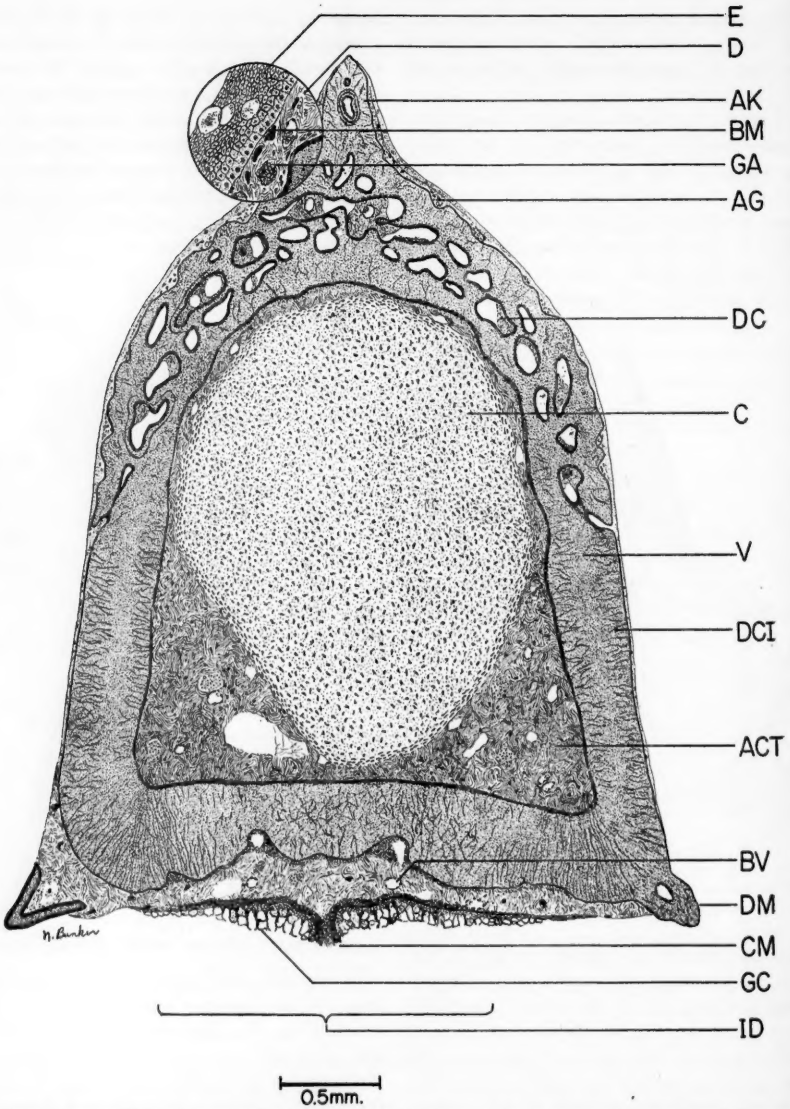
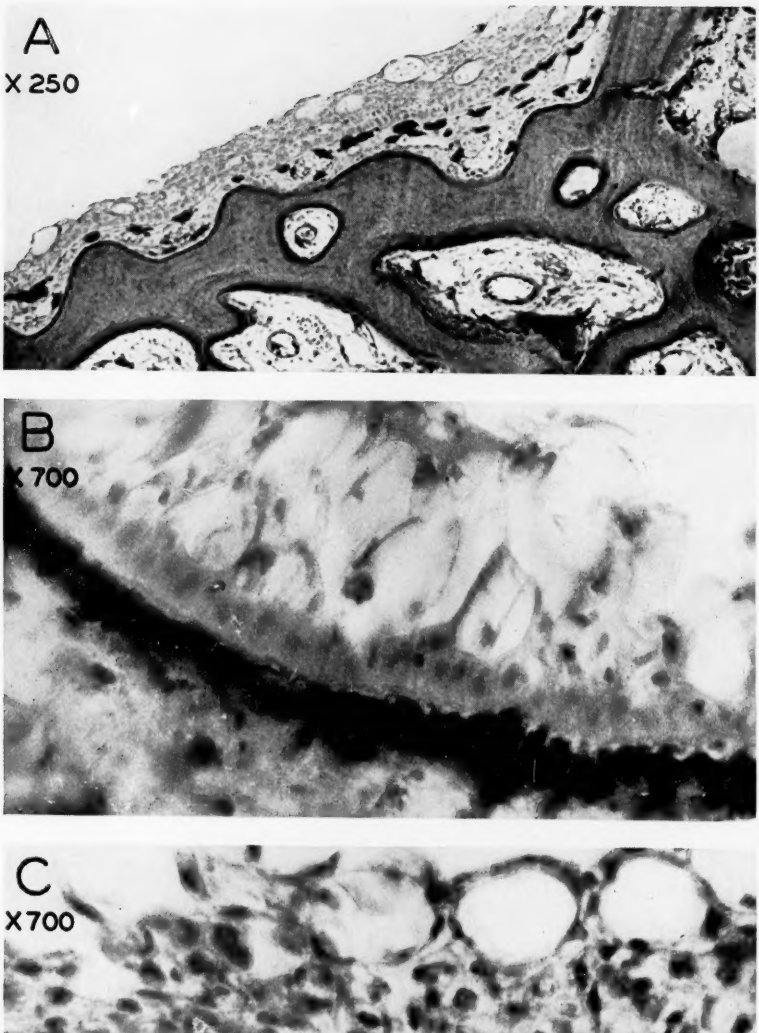


Fig. 4. Cross section of dorsal spine. E, epidermis; D, dermis; AK, anterior keel; BM, basement membrane; GA, glandular acinus?; AG, anterolateral groove; DC, dentinal canals; C, cartilage; V, vasodentine; DCI, dentinal canaliculi; ACT, areolar connective tissue; BV, blood vessel; DM, dentate margin; CM, connecting membrane; GC, glandular cells; ID, interdentate depression.

the spine becomes convex. At a lower level, the basal supporting cartilage comes into view.

The spine is covered externally by a thin layer of integument which consists of two layers—an outer epidermis and an inner dermis. The epidermis is avascular, comprised of squamous epithelium, and rests on an acellular basement membrane. Underlying the epidermis is the vascularized layer of fibrous connective tissue, the dermis. In the uninjured spine, this



Photomicrographs showing glandular epithelium in (A) region of anterolateral grooves, (B) interdentate depression, and (C) dorsal fin groove.

integument completely envelopes the spine except along the midline of the interdentate depression where the dorsal fin joins the spine. In sections where the spine is still connected with the soft dorsal, it will be observed that the integument is continuous with that of the dorsal fin. The epithelium is most concentrated in the anterolateral grooves just posterior to the anterior keel of the spine (Pl. I, A) and in the region of the interdentate depression (Pl. I, B). Posterior to the first dorsal ray, the epithelial layer thins out until it is only one or two cells in thickness. Pigment granules are interspersed throughout the epithelium, but are most numerous in the interdentate depression. Mucous cells may also be seen scattered at infrequent intervals throughout this same layer.

In examining sections from the spines of young fish, 250 mm. in length, or less, one receives the impression that the epithelium in these two concentrated areas is the ordinary epidermal variety such as may be found elsewhere covering the body of the fish. However, examination of the spines of older specimens reveals concentrations of fully developed glandular epithelium in the epidermal layer of the anterolateral grooves, the interdentate depression, the connecting membrane between the spine and the first dorsal ray, and in the epithelial lining of the groove on the back which receives the dorsal fin when in the depressed position (Pl. I, C). Furthermore, it will be noted that the cells of this glandular epithelium are in the process of secretory activity as evidenced by vacuolation, increased cytoplasmic area, and phantom nuclei. Some of the more superficial cells in the region of the interdentate depression appear to be undergoing dissolution or rupture. These observations strongly suggest a holocrine type of secretion; moreover, these concentrated glandular patches are not seen elsewhere in the epidermis covering the dorsal fin or in the integument of the back.

By carefully examining the dermis located in the anterolateral grooves and the interdentate depression, one will see an occasional clump of what appears to be glandular tissue. The cells of these acini, if they are such, also appear to be undergoing secretory activity. The cells are swollen, vacuolated, and have phantom nuclei, but do not appear as active as similar cells seen in the epidermis. There is no evidence of ducts and their exact nature is unknown. It is our impression that the venom is probably secreted by the glandular epithelium in the epidermal portion of the integument of the spine and the adjoining connecting membrane of the dorsal fin. Whether or not the acini in the dermis are actively engaged in venom production cannot be determined at this time. Also scattered throughout the dermis are numerous vascular channels which contain nucleated blood cells.

Goodrich (1909: 168) stated that the spine does not contain an enamel layer. Likewise, we have been unable to demonstrate that such a layer exists. There is, however, a light blue line that is occasionally observed around the periphery of the vasodentine. If this line is compared with the enamel line of the dorsal spine of *Squalus suckleyi* (Girard), it will be seen that there is considerable difference both in structure and width.

In cross sections taken at the level of the middle third of the spine, it will be observed that the vasodentine layer forms a broad wall which completely encircles the inner core of cartilage. Subsequent sections taken from lower levels reveal that this dentinal wall thins out posteriorly until it gradually disappears. The anterior half of this wall, including the keel, contains many dentinal canals. These canals are occupied mostly by areolar connective tissue and are heavily vascularized with small blood vessels which, in some cases, are filled with nucleated erythrocytes. Some of these dentinal canals open into the small grooves on the anterolateral portion of the spine. The inner edge of the dentinal wall of young spines shows a light-staining area which is noncalcified vasodentine.

The odontoblast layer adjoins the inner margin of the dentinal wall and consists of a row of darkly-stained cells with large nuclei, one or two cells in thickness. The odontoblasts produce the vasodentine. When the process of vasodentine formation has been completed, the odontoblasts cease to function and apparently disappear, because in older spines this layer is not detected. The remainder of the tissue between the odontoblast layer and the cartilaginous core is comprised of loose areolar

connective tissue which is interspersed with small blood vessels containing nucleated blood cells. The core itself is composed of embryonic hyaline cartilage. This cartilage continues up about 6/7 of the length of the spine. In the terminal portion the cavity of the spine is filled with loose areolar connective tissue.

HISTOLOGICAL TECHNIQUES USED.—Since special histological preservatives were not available at the time the ratfish were captured, the microscopic sections described in this report were originally preserved in 5 percent formalin. Decalcification of the spines was accomplished by two methods: the phloroglucin-nitric acid and formol-nitric acid methods as given by Carleton (1926: 210–11). The former technic was found to be the more satisfactory of the two, since the phloroglucin permits the use of stronger acids with minimal damage to the tissues. It was also found that if decalcification was performed under a vacuum of about 600 mm. of mercury, the process took less than an hour instead of the several days usually required. After decalcification, the spines were washed for twelve hours in running water, and then carried through a technique of embedding with hot, low-viscosity nitrocellulose, according to the method of Koneff and Lyons (1937: 57–59). This method was used in preference to the standard celloidin technique since it takes less time for the infiltration and embedding processes and still gives satisfactory results. The spines were sectioned on a sliding microtome and stained with triosin and Harris' haematoxylin.

ACTION OF THE VENOM

An extensive search through scientific literature failed to reveal any information regarding the venom of this fish. Hence, it was considered advisable to conduct a series of short experiments on the venom of *Hydrolagus colliei* in an attempt to determine its toxicity.

Judging from the histological evidence available, it appears that the venom apparatus of *Hydrolagus colliei* consists of the following: the vasodentinal dorsal spine (which serves as the traumatic agent), the glandular epithelium of the epidermal layer of the anterolateral grooves, the interdentate depression, the connecting membrane between the dorsal spine and fin, and the glandular epithelium lining the groove of the dorsal fin. It is believed that the glandular epithelium in the areas listed above are the venom producing sites.

While at Walla Walla College Biological Station at Anacortes, Washington, during June, 1950, an exceptionally fine specimen of *H. colliei* was captured on a setline at Shipharbor, Fidalgo Island, in about five fathoms of water. The fish measured 595.0 mm. in total length and the dorsal spine was 103.0 mm. long. An intradermal scratch test was performed on the volar surface of the left forearm of the senior author. The test was made by pressing the tip of the dorsal spine into the skin, but not deep enough to produce bleeding. An area of ischemia having raised borders was surrounded by a zone of erythema, which appeared in three to four minutes. The zone measured about 20.0 mm. in diameter. In about five minutes there was a mild, dull ache in the area about the scratch which lasted for about ten minutes. The eruption disappeared completely in about 30 minutes. During the same period of time another test was performed in a similar manner and on the same arm, using the dorsal spine of *Squalus suckleyi*. Interestingly enough, no reaction was produced.

As a result of the cooperative efforts of Dr. Rolf L. Bolin of the Hopkins Marine Station, Pacific Grove, California, and Mr. Ellis Ripley of the California State Department of Fish and Game, the authors were able at a subsequent date to procure additional ratfish spines for pharmacological tests. Tissue extracts were prepared from the dorsal spines of adult ratfish that had been captured in Monterey Bay, California, during January and September, 1951. The specimen material was preserved by freezing. The technique utilized in our experiment was as follows: tissue was scraped from the interdentate depression of twelve ratfish dorsal spines; the scrapings were weighed and then placed in a mortar, and ground with a pestle, to which was added—in the case of extracts 72-1 and 305-5—physiological saline in the proportion of 8.0 ml. of saline for every 1.0 gm. of tissue. Extracts 67-1 and 68-1 were prepared with the use of 0.1 N. HCl instead of saline, after the method of Sommer and Meyer (1937: 565-71), which according to Sommer (*in litt.*) has been used with considerable success in some of their comparative

studies on fish poisons. The mixture was then ground thoroughly and centrifuged at 2000 r.p.m. for 25 minutes using a head with an eight-inch radius. The acidulated extracts were boiled in a water bath after the grinding process and then centrifuged. The test was performed by injecting 1.0 ml. of the supernatant fluid intraperitoneally into white laboratory mice. A control was run (Table II) using skin taken from the dorsum of the fish in the vicinity of the dorsal fin. The extracts for the control were prepared in the same manner. The results of these tests are given in Tables I and II, respectively.

TABLE I

RESULTS OF INJECTING EXTRACTS PREPARED FROM THE INTERDENTATE TISSUE OF *Hydrolagus colliei*

Ext. No.	Mouse No.	Mouse wt.	Reaction time	Results
Physiological Saline Extracts:				
72–1	1	24.9 gm.	14:00:00	Intraperitoneal injection, followed by immediate agitation. Calm after one minute. Dragging hind limbs and stretching movements—no true paralysis observed.
			14:15:00	
			15:55:00	Inactive—refuses to move when probed.
			Second day	
			09:00:00	Inactive, eyes closed, fur ruffled; remained in this condition throughout the day.
			Third day	
			20:30:00	Dead.
"	2	22.2 gm.	14:03:00	Intraperitoneal injection, followed by mild jerking motions.
			15:55:00	Inactive
			Second day	
			09:00:00	Inactive—similar in appearance to mouse No. 1.
			Third day	
			14:00:00	Dead.
"	3	20.0 gm.	14:11:00	Intraperitoneal injection, followed by mild agitation.
			16:00:00	Asymptomatic.
			Second day	
			09:45:00	Dead.
"	4	22.2 gm.	14:13:00	Intramuscular injection into left thigh. Dragged left leg for about one hour and then gradually recovered. By 16:00:00 of the same day, the mouse was asymptomatic and remained so.
Acidulated Extracts:				
67–1	1	17.5 gm.	15:12:50	Intraperitoneal injection.
			15:25:00	Mild respiratory distress.
			16:25:00	Inactive, fur ruffled, refused to eat, eyes closed.
			08:30:00	Died during the night.
"	2	18.0 gm.	15:20:40	Intraperitoneal injection.
			15:25:00	Respiratory distress.
			16:25:00	Inactive—similar in appearance to mouse No. 1.
			Second day	Asymptomatic—survived.

Extracts prepared from the area of the dorsal fin groove gave results similar to the interdentate tissue extracts when injected intraperitoneally into white mice.

Samples were also taken of muscle, liver and oviduct and prepared in the same manner as were the other physiological saline extracts. The muscle and liver extracts proved to be innocuous, but the oviduct preparation was found to be toxic. The results of the oviduct extract are given in Table III.

The oviduct apparently contains a toxin of sufficient potency that, when ingested by human beings, it may have serious consequences. At any rate, it would be safest to conclude that the reproductive organs of this fish should not be eaten, nor should they remain in the body of the fish during the cooking process.

TABLE II

Control

RESULTS OF INJECTING EXTRACTS PREPARED FROM THE SKIN OF THE DORSUM OF *Hydrolagus colliei*

Ext. No.	Mouse No.	Mouse wt.	Reaction time	Results
Physiological Saline Extracts:				
305–5	1	18.0 gm.	10:42:35 11:10:14	Intraperitoneal injection. Asymptomatic.
"	2	18.5 gm.	10:43:50 11:10:14	Intraperitoneal injection. Asymptomatic.
"	3	18.5 gm.	10:45:20 11:10:16	Intraperitoneal injection. Asymptomatic.
"	4	18.5 gm.	10:47:00 11:10:16	Intraperitoneal injection. Asymptomatic.
"	All			All mice were checked 24 hours later and continued to remain asymptomatic.
Acidulated Extracts:				
68–1	1	23.6 gm.	13:45:00 14:10:00 15:55:00	Intraperitoneal injection. Asymptomatic. No abnormal movements noted. Inactive, otherwise asymptomatic.
"	2	23.5 gm.	13:48:00 14:10:00 15:55:00	Intraperitoneal injection. Asymptomatic. Slight cramping of leg muscles, inactive.
"	3	21.5 gm.	13:50:30 14:10:00 15:55:00	Intraperitoneal injection. Asymptomatic. Asymptomatic.
"	4	24.5 gm.	13:58:00 14:10:00 15:55:00	Intraperitoneal injection. Asymptomatic Asymptomatic

SUMMARY

A detailed description is given of the gross and microscopic anatomy of the dorsal spine and adjacent structures of the ratfish, *Hydrolagus colliei*.

Histological studies reveal that the dorsal spine is enveloped within a layer of stratified squamous epithelium which in the uninjured state is continuous with the epithelium covering

the dorsal fin. The epithelium is most concentrated in the region of the anterolateral grooves, interdentate depression, and the connecting membrane between the spine and the first dorsal ray. Numerous glandular cells in the process of secretory activity may be observed scattered throughout these concentrated areas of stratified squamous epithelium. Moreover, glandular tissue is not observed to the same degree in integument taken from other areas of the dorsum of the fish.

Pacific ratfish is capable of inflicting fatal injuries to man. The chemical and pharmacological properties of the venom are unknown and in need of further study.

Extracts prepared from the muscle, liver, and oviduct were also tested by intraperitoneal injection into mice. Only the oviduct proved to be toxic. The reproductive organs of this fish are probably not safe to eat.

ACKNOWLEDGMENTS.—We wish to express our sincere appreciation to Dr. Rolf Bolin, Mrs. Esther Matthews and Miss Colene Hooper for their many excellent suggestions and criticisms.

TABLE III

RESULTS OF INJECTING AN EXTRACT PREPARED FROM THE OVIDUCT OF *Hydrolagus colliei*

Ext. No.	Mouse No.	Mouse wt.	Reaction time	Results
305–3	1	17.0 gm.	10:32:45	Intraperitoneal injection.
			11:10:10	Asymptomatic.
				Died during the night.
"	2	17.0 gm.	10:34:00	Intraperitoneal injection.
			11:10:10	Asymptomatic.
			Second day	
			9:50:00	Inactive, eyes glued shut, hair ruffled.
			12:14:40	Dead.
"	3	17.0 gm.	10:38:20	Intraperitoneal injection.
			11:10:12	Asymptomatic.
			Second day	
			9:50:00	Similar to mouse No. 2.
			10:50:00	Dead.
"	4	18.0 gm.	10:40:05	Intraperitoneal injection.
			11:10:12	Asymptomatic.
			Second day	
			9:50:00	Similar to mouse No. 2.
			12:00:00	Dead.

Acidulated and saline extracts were prepared from tissues scraped from the interdentate depression of the dorsal spine. Controls were run using extracts prepared from integument taken from an area adjacent to the dorsal fin. Tests were made by intraperitoneal injections into white laboratory mice. Extracts from the interdentate tissue killed mice in about 24 to 54 hours. Mice injected with the control extracts remained asymptomatic, thus demonstrating that the interdentate tissue does produce a toxin.

The venom of *Hydrolagus colliei* is probably not very potent, and it is doubtful if the

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SCHOOL OF TROPICAL AND PREVENTIVE MEDICINE, COLLEGE OF MEDICAL EVANGELISTS, LOMA LINDA, CALIFORNIA, and WALLA WALLA COLLEGE, WALLA WALLA, WASHINGTON.

Notes on the Scorpaenid Fishes of Washington and Adjacent Areas, with a Key for their Identification

DAYTON L. ALVERSON AND ARTHUR D. WELANDER

THE authors have been gathering material during the past two years for a study of the rockfishes of the genus *Sebastodes* and present the following notes and key in an attempt to facilitate the identification of the scorpaenids of Washington, British Columbia and neighboring regions.

During this study new records were obtained that extend the known range of *S. aleutianus* and *S. crameri*. *S. columbianus* was made a subspecies of *S. melanops*, and *S. babcocki* was synonymized with *S. rubrivinctus*. Because of the expanding rockfish fishery on the Pacific Coast, further additions to our knowledge of *Sebastodes* are to be expected. At present a rapid, reliable method of identification of the species is a real need.

The authors wish to express their thanks for the considerable help and material from the following: Dr. Leonard P. Schultz, Curator of Fishes, U. S. National Museum; Robert Parker, Research Biologist, Alaska Department of Fisheries; and Charles K. Phenicie, Chief Biologist, Montana Department of Fish and Game.

NOTES ON THE GENUS *Sebastodes*

Peritoneum.—The peritoneum was found to be a reliable character to distinguish all specimens studied with the exception of *Sebastodes rubrivinctus*. In this species the color of the peritoneum of 208 specimens varied as follows: black (26), silver with black blotches (41), dusky or pepper effect (33), and silver (108). No correlation was found between peritoneum color and size in this species. The variation in color may well have been the reason why the species was redescribed as *Sebastodes babcocki* by W. F. Thompson (1915). Since we are unable to find valid taxonomic differences between the two species, *S. babcocki* is considered to be a synonym of *S. rubrivinctus*.

Comparison of S. melanops with S. columbianus.—A number of *Sebastodes columbianus* (Hubbs and Schultz, 1933) from the mouth of the Columbia River were examined in an attempt to distinguish this form from specimens of *Sebastodes melanops* taken from coastal regions. Although there seems to be a slight difference in unbranched pectoral ray counts and color pattern, intermediate types convince us that *columbianus* should be recognized as a subspecies only (Table I).

Comparisons of the internal and external anatomy, osteology, and morphology indicate that the species are alike. The authors therefore believe that the form from coastal waters should be called *Sebastodes melanops melanops* and that from the Columbia River mouth, *Sebastodes melanops columbianus*. The latter

subspecies has a slightly darker appearance; the lighter lateral band found in *S. m. melanops* is not as distinct as it is in *S. m. columbianus*.

Range Extensions.—A specimen of *Sebastodes aleutianus* was taken by the drag boat ALTEN off Newport, Oregon, in 130 fathoms, and was brought into Newport on August 8, 1949. Since that time, several specimens of the same species have been obtained from the same area. As far as is known, this is a new southern record for this fish, other records being limited to the Aleutian chain and Southwestern Alaska. As the species is not described in literature from this area, the following description, taken from the above specimen, is given:

Dorsal XIII-14; anal III-8; pectoral 18. Approximately 54 oblique scale rows above lateral line. Maxillary and mandible roughly scaled. Lower jaw slightly projecting and symphyseal knob moderately developed; interorbital space slightly convex. The following spines are present: nasal, short and sharp; preocular, strong; supraocular; postocular; and tympanic. These spines are not readily distinguished. The accompanying ridges, although strong, are broken into numerous serrations, and accessory spines may appear between the spines mentioned above. Two spines are present near the beginning of the parietal ridge. Parietals are strong, more or less serrated above. Nuchal spines are present, with a small accessory spine between parietal and nuchal. Coronal spines are present. The lacrymal has one blunt spine anteriorly and three sharp spines posteriorly. The suborbital is broken up into small spines, with three sharp prominent spines across the base of the suborbital stay, the anterior one strongest. Two sharp, strongly divergent spines are present on the opercle. The preopercle has five spines. Two small spines lie near the junction of opercle and subopercle. A spine is present just above the humeral region, and two others lie just dorsal to this. The color is red, as in *Sebastodes miniatus*, and all fins are edged in black. The peritoneum is silver.

In July, 1949, a small rockfish was collected off Newport, Oregon, in 70 fathoms of water by the drag boat HAROLD A. This specimen was tentatively identified as *Sebastodes crameri* and placed in the University of Washington collection for further study. Several weeks later five more samples of the same fish were obtained from off Willapa, Washington, in 74 fathoms by the drag boat MARION F. These specimens were forwarded to the U. S. National Museum, to be compared with the holotype of *Sebastodes crameri*. The specimens were examined and compared by Dr. Leonard P. Schultz, who returned them with the following remarks: "The three specimens of *Sebastodes* from off Willapa Bay are definitely *Sebastodes crameri*. I have compared them with the type and allowing for the usual variations every-

TABLE I

UNBRANCHED PECTORAL RAY COUNTS OF THE COASTAL AND COLUMBIA RIVER FORMS OF *Sebastodes melanops*

Subspecies	Number unbranched pectoral rays					Total	Ave.
	7	8	9	10	11		
S. melanops melanops	1	6	28	82	4	121	9.7
S. melanops columbianus	..	5	40	33	2	80	9.3

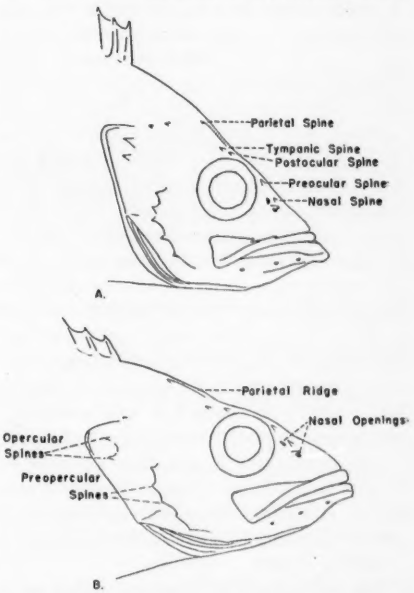

Fig. 1. Lateral views of hypothetical rockfish showing external characters referred to in text.

thing is the same." These fish constitute the first record of *Sebastodes crameri* from off the Washington coast. During the same period when these specimens were collected, a deep-water drag fishery operating at depths of 100 to 200 fathoms was developed off Newport, Oregon. An examination of the landings at the Yaquina Bay Fish Company revealed that specimens of *Sebastodes crameri* were commonly taken along with *Sebastodes alutus* and *Sebastodes diploproa*.

In the summer of 1950 a large number of juvenile rockfish were collected from stomachs of albacore, *Thunnus germo* (Lacépède), by the U. S. Fish and Wildlife exploratory vessel JOHN N. COBB. Samples of juvenile rockfish were taken from Cape Blanco, Oregon, to the northern end of the Queen Charlotte Islands and from 30 to 380 miles offshore. An examination of the collected material revealed that *Sebastodes crameri* and *Sebastodes alutus* made up the bulk of the rockfish eaten by the albacore in these waters and that they were both present throughout the range of the collected material. The young taken from the albacore were in good condition, some being regurgitated on deck alive. Of 220 albacore stomachs examined, rockfish were found to be the most prominent food, both from numerical and volumetric standpoints. It would thus appear that *Sebastodes crameri* must be relatively common in deep water along the coasts of Oregon, Washington, and British Columbia, and that their young are pelagic in nature and found dispersed in offshore waters.

The confusion in the literature dealing with *Sebastodes crameri* is typical of the genus *Sebastodes*. The species was first described by Jordan (1897: 451) as having the supraocular spine present and with black bands along the back. Current keys to the genus, following an error made in Jordan and Evermann (1898: 1775), have placed the species in a category having both the supraocular spine and black bands on the back absent. The young of this species are very strongly marked with jet black vertical bands which fade somewhat in the older specimens but are always noticeable. A description of a three-inch specimen taken off Newport, Oregon, is given below:

Dorsal XIII-14; pectoral 19, lower 9 simple; anal III-7; vertical scale rows above the lateral line 88; tubes in lateral line 47; preocular, supraocular, postocular, and tympanic spines all present and well developed; five preopercular spines all pointing posteriorly, the second and third spines strongest; two spines present on opercle, slightly diverging posteriorly; interorbital space flat; lower jaw only slightly projecting; scales on mandible, maxillary, and premaxillary; gill rakers long and slender, 9/21. Color as follows: Creamy yellow to orange with four black bands, one under first to third dorsal spines, running downward and slightly forward, ending under opercle; the second band from the fifth to seventh dorsal spines running down and under the middle of depressed pectoral fin; the third band from about the eighth to eleventh dorsal spines running down and across lateral line, the anterior border following posterior margin of the pectoral fin; the fourth band from about second soft dorsal ray to tenth soft dorsal ray running down and across the lateral line in more or less a V-shape, the apex of the V at about the third to fifth anal fin rays; black blotch on caudal peduncle; all bands continuing on to the dorsal fin; anal with black blotch; peritoneum dark brown to black.

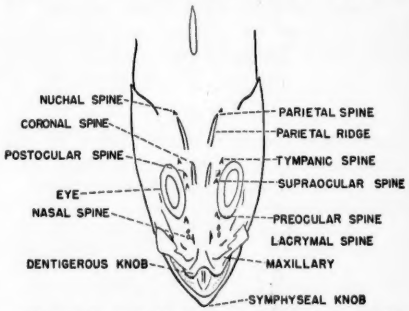

Fig. 2. Dorsal view of a hypothetical rockfish showing external characters referred to in text.

ARTIFICIAL KEY TO THE FAMILY SCORPAENIDAE OF WASHINGTON, BRITISH COLUMBIA AND NEIGHBORING WATERS

1a.–Suborbital ridge starting below eye, prominent and continuous to edge of opercle. Dorsal spines 15 or more: soft rays usually 8–10.

2a.–Branchiostegals without scales. Roundfin rockfish..... *Sebastolobus alascanus* Bean

2b.–Branchiostegals scaly. Angelfin rockfish.....*Sebastolobus altivelis* Gilbert

1b.–Suborbital ridge not prominent and not continuous. Dorsal spines less than 15, usually 13: soft rays 11 or more, usually 13.

3a.–Peritoneum white, pale yellow, or silver; never dark.

4a.–Supraocular spine present; postocular and, usually, tympanic spines developed (Fig. 1) (See also 4b and 4c).

5a.–Spines below eye at base of suborbital stay; lacrymal with 3 spines on posterior portion, a more blunt spine anteriorly. Nuchal and coronal spines present. Blacktip rockfish.....*Sebastodes aleutianus* Jordan and Evermann

5b.–No spines below eye. Nuchal and coronal spines absent.

6a.–Scales small, about 80 oblique rows above lateral line. Tympanic spines usually absent. Color mostly rusty brown. Shortspine rockfish.....*Sebastodes brevispinis* Bean

6b.–Scales medium, oblique rows above lateral line less than 60. Tympanic spines present. Color orange or red.

7a.–Gill rakers short and rough, 21 or fewer on lower limb of first arch. Interorbital space flat or concave. Third preopercular spine multifid. Red rockfish.....*Sebastodes ruberrimus* Cramer

7b.–Gill rakers long and slender, 22 or more, usually 26, on lower limb of first arch. Interorbital space somewhat convex. Third preopercular spine not multifid.

8a.–Scales on head cycloid, those on mandible smooth. Posterior lacrymal spine strong. Body without dusky black along sides. Orange rockfish.....*Sebastodes pinniger* (Gill)

8b.–Scales on head ctenoid, those on mandible rough. Lacrymal spines (if present) blunt and weak. Body with dusky black along sides, the background brick-red. Vermilion rockfish.....*Sebastodes miniatus* (Jordan and Gilbert)

4b.–Supraocular spine absent; postocular and tympanic spines present, or rarely absent (see also 4c).

9a.–Scales on head mostly cycloid. Posterior lacrymal spine multifid. Body with bright red stripes on pale pink to white background. Spanish flag.....*Sebastodes rubrivinctus* (Jordan and Gilbert)

9b.–Scales on head ctenoid.

10a.–Coronal spines present. Brown rockfish.....*Sebastodes auriculatus* (Girard)

10b.–Coronal spines absent.

11a.–Nuchal spines present. Body with jet black vertical bars. Blackbanded rockfish.....*Sebastodes nigrocinctus* (Ayres)

11b.–Nuchal spines absent. No jet black vertical bars on body.

12a.–Body with prominent yellow stripe, originating at region of third dorsal spine and curving posteroventrally along lateral line to caudal peduncle. Stripe is delineated by the dark blue-black coloring of rest of body. Yellow rockfish.....*Sebastodes nebulosus* (Ayres)

12b.–No prominent yellow stripe on body, as above.

13a.–Longest dorsal spine 2.0 or more in head. Minute scales on lower jaw below tip of maxillary. Second and third anal spines about equal. Copper rockfish.....*Sebastodes caurinus* (Richardson)

13b.–Longest dorsal spine about 1.8 in head, less in larger specimens. No scales on lower jaw. Body usually with brownish orange spots below. Second anal spine usually larger than third. Orangespotted rockfish...*Sebastodes maliger* (Jordan and Gilbert)

4c.–Supraocular, postocular, and tympanic spines absent (if present, minute and variable).

14a.–Scales in oblique rows 90 to 105; pectoral rays 15. Bocaccio.....*Sebastodes paucispinis* (Ayres)

14b.–Scales in oblique rows above lateral line less than 80. Pectoral rays 17 to 20.

15a.–Tips of nasal spines exposed.

16a.–Pectorals usually with 19 rays, the unbranched rays typically 10. Depth 2.4 to 2.9 in standard length. Posterior margins of scales edged with black, forming a definite pattern.

17a.–Unbranched pectoral rays 8 to 11, usually 10. Dorsal soft rays 13 to 16, usually 15. Anal soft rays 7 to 9, usually 8. A rather prominent light band along midsides, just below lateral line anteriorly, along lateral line posteriorly. Coastal black rockfish.....*Sebastodes melanops melanops* (Girard)

17b.–Unbranched pectoral rays 8 to 11, usually 9. Dorsal soft rays 13 to 14, usually 14. Anal soft rays 7 or 9, usually 7. Light lateral band indistinct or absent. Columbia River black rockfish ..... *Sebastodes melanops columbianus* (Girard)

16b.–Pectorals usually with 18 or fewer rays (rarely 19), the unbranched rays typically 9. Depth 2.0 to 3.5 in standard length. Faded yellow blotch on tail of fresh specimens. (In preservative, body dark brown above, becoming lighter below lateral line.) Yellowtail rockfish ..... *Sebastodes flavidus* Ayre

15b.–Tips of nasal spines not exposed. Bass rockfish ..... *Sebastodes serranoides* Eigenmann

3b.–Peritoneum black, brown, gray, or with dark areas.

18a.–Supraocular, postocular and tympanic spines present (see also 18b and 18c).

19a.–Coronal and nuchal spines present; posterior lacrymal spines multifid. Gill rakers long and slender. Blackthroat rockfish ..... *Sebastodes introniger* (Gilbert)

19b.–Coronal spines absent. No multifid lacrymal spines.

20a.–Nuchal spines present and separated from parietal ridge. Deepsea rockfish ..... *Sebastodes rupestris* (Gilbert)

20b.–Nuchal spines absent.

21a.–Body with five definite black blotches, three under spinous dorsal, one under soft dorsal, one on caudal peduncle. Pectoral rays usually 19. Blackmouth rockfish ..... *Sebastodes crameri* Jordan

21b.–Body without definite black blotches, although *Sebastodes alutus* may have faint black markings under spinous dorsal. Pectoral rays usually fewer than 19.

22a.–Dorsal XIII-14 or 15, usually XIII-15; anal III-8, rarely III-7. Lower jaw strongly projecting, with well developed symphyseal knob. No pink stellate spots on body. Longjaw rockfish ..... *Sebastodes alutus* (Gilbert)

22b.–Dorsal XIII-13; anal III-6; jaws about equal. Pink stellate spots on body. Rosy rockfish ..... *Sebastodes rosaceus* (Gilbert)

18b.–Supraocular spines absent. Postocular and tympanic spines present (see also 18c).

23a.–Interorbital noticeably convex, never flat or concave.

24a.–Lower jaw strongly projecting. Prominent light pink area along lateral line (white in preserved specimens). Redstripe rockfish ..... *Sebastodes proriger* (Jordan and Gilbert)

24b.–Lower jaw little projecting. No light pink or light-colored area along lateral line. Mottled rockfish ..... *Sebastodes emphaeus* Starks

23b.–Interorbital flat or concave.

25a.–Scales in oblique rows above lateral line more than 64. Soft dorsal 14 or 15. Usually of small size, maximum length 8.5 inches. Bigeye rockfish ..... *Sebastodes zacentrus* (Gilbert)

25b.–Scales in oblique rows above lateral line fewer than 64. Soft dorsal 11 to 14. Size larger.

26a.–Gill rakers on lower limb of first arch 28–31. Slender rockfish ..... *Sebastodes wilsoni* Gilbert

26b.–Gill rakers on lower limb of first arch fewer than 28.

27a.–Lacrymal spines present, strong except in *S. saxicola*.

28a.–Posterior lacrymal spines not multifid. Gill rakers long and slender.

29a.–Premaxillaries greatly produced, with prominent dentigerous knobs. Lower jaw little projecting. Lacrymal spines (Fig. 1) pointed downward. Splitnose rockfish ..... *Sebastodes diploproa* (Gilbert)

29b.–Premaxillaries not produced. Lower jaw strongly projecting, entering upper profile of head (Fig. 1A). Lacrymal spines pointing backward. Popeye rockfish ..... *Sebastodes saxicola* (Gilbert)

28b.–Posterior lacrymal spines usually multifid. Gill rakers short and very stout. Lower jaw little projecting (Fig. 1B). Body with red stripes on pale pink to white background. Spanish flag ..... *Sebastodes rubrivinctus* (Jordan and Gilbert)

27b.–Lacrymal spines absent. Lower jaw bluntly projecting. Light pink area along lateral line (white in preserved specimens). Striped rockfish ..... *Sebastodes elongatus* (Ayres)

18c.–No supraocular, postocular, or tympanic spines, or if present, minute and irregular.

30a.–Preocular spines usually present, the ridges always present. Anal III-9 to 11. Priest fish ..... *Sebastodes mystinus* (Jordan and Gilbert)

30b.–Preocular spines absent. Anal III-8 or 9. Dusky rockfish ..... *Sebastodes ciliatus* Tilesius

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Food of the Striped Marlin, *Makaira mitsukurii*, from New Zealand[1]

JAMES E. MORROW

THE striped marlin, *Makaira mitsukurii* Jordan and Synder, is found in the tropical and semi-tropical waters of the Indo-Pacific. Like all marlins, it is characterised by the elongate upper jaw, resembling a marlin spike, from which the group derives its popular name. The striped marlin may be distinguished from other Pacific marlins by its relatively higher dorsal fin, lesser depth of body, and the presence of about 14 silvery to blue vertical stripes on the body.

In common with other members of this group, the striped marlin is familiar to salt-water sportsmen. Its speed and strength, coupled with large size and spectacular behavior when hooked, have made it the object of rather intensive sports fisheries wherever it is abundant.

Despite its popularity, however, relatively little is known about it, or indeed about any of the marlins. Various fishing clubs have kept catch records, providing limited information on fluctuations in abundance. But except for a few isolated papers (*e.g.*, Wallace and Wallace, 1942), there are virtually no published accounts relating to the biology of any of the marlins. The present paper treats of a relatively small number of fish from a single locality, but it exposes to some degree one phase of the biology of the striped marlin—its feeding habits. Comparative studies of this sort, carried on throughout its geographic range, should be of value to sport and commercial fishermen alike, and may be expected to stimulate more detailed investigations.

[1] Scientific results of the Yale-New Zealand Expedition, 1948.

METHODS

The striped marlin from which the stomachs were taken for examination were caught on rod and line in the region of Cape Brett and the Cavalli Islands, New Zealand, between January 31 and March 3, 1948. The majority of the fish were caught by members of the Yale-New Zealand Expedition, the others by guests at Otehei Lodge, Otehei Bay, N. Z. Most of the fish were taken by trolling, using kahawai (*Arripis trutta*) for bait; a few were caught still-fishing. In general, the fish were examined in the evening of the day they were caught, although on a few occasions it was necessary to postpone examination until the following day. The usual procedure in the field was to remove the stomach contents, wrap them in cheese cloth and preserve them in 10% neutral formalin to await detailed examination in the laboratory.

Each package of stomach contents was examined separately. The various objects were sorted and identified as completely as possible. Some of the contents were easy to identify, being whole or only slightly digested. Other constituents were badly broken down. However, it was usually possible to identify even the well-

digested material by comparing it with other specimens in which digestion had not proceeded so far. One or more items almost always resisted digestion longer than others, but comparison with those of the fresher material permitted positive identification of the great majority of the digested specimens. Thus, the shape and other characteristics of vertebrae, skulls, jaws and scales were particularly useful. The bases of the dorsal and anal finlets of *Scomberesox saurus* (Walbaum) persisted after most external characters had disappeared and served to identify a number of specimens of this species.

A total of 53 stomachs were examined, 38 of which contained food. Of the 15 fish with empty stomachs, nine were seen to regurgitate and evert the stomach pouch while being brought to the boat. The remaining six fish may have regurgitated or may have had empty stomachs before being hooked.

The amount of food in the stomachs varied widely. The heaviest food mass found weighed 6318 grams (13.9 lbs.), while the lightest was only 124 grams (about 0.27 lb.). However, the ability of these fish to regurgitate, either partially or completely, casts considerable doubt on the validity of an attempt at quantitative analysis of stomach contents.

Discussion

It was apparent early in the course of this work that fin fishes formed the chief articles of diet for the striped marlin. This was amply confirmed by the complete results (Table I) which show only two species of cephalopods in addition to fishes. Among the fishes eaten by the striped marlin, the dominant item was the saury or skipper, *Scomberesox saurus*. Ichthyologists of New Zealand and Australia customarily use the specific name *forsteri* for this fish. However, examination of our specimens forces us to agree with Barnard (1925) that there is no difference between *forsteri* and *saurus*. This species far outnumbered all the others combined. A total of 195 specimens of *S. saurus* was found in 27 stomachs, thus being present in more than 70 percent of the stomachs containing food. The number of sauries in each stomach varied from one to 16, with an average of 7.2 per stomach. The total number found (195) represents nearly 75 percent of all individuals of all species, including the cephalopods. The total weight of *S. saurus* in the stomachs was 11,055 grams, representing 15 percent of the total weight of all stomach contents.

The kahawai, *Arripis trutta* (Schneider), occurred in 17 stomachs, averaging 1.2 specimens per occurrence for a total of 21 specimens. Ten of these were baits and could be distinguished from those which had been taken free by the presence of twine in the jaws where the hook had been sewed in place. Although there were nearly ten times as many *S. saurus* as *A. trutta*, the latter, with an average weight of 2151 grams, had a total weight more than four times as great as that of *S. saurus* and constituted 61.4 percent of the total weight of the stomach contents. These two species thus composed 82.1 percent by number and 76.4 percent by weight of the total.

Other organisms found more than once were the snapper, *Pagrosomus auratus* (Schneider); butterfly perch, *Caesioperca lepidoptera* (Schneider); and some carangids which were so far digested as to prevent further identification. The squid, *Loligo sp.*, appeared eight times, with a total of 13 specimens. Unidentifiable fish flesh was found in ten stomachs. It was not possible to determine the number of individuals represented in this category, but it represented less than 1.5 percent of the total weight of the stomach contents.

Parasitic nematodes, *Contracaecum incurvum* (Rudolphi), were present without exception. In stomachs containing food, these worms were to be found entangled in the food mass, regardless of its species components. In otherwise empty stomachs, the worms were located in the folds and crevices of the wall of the stomach pouch. These parasites were invariably present in considerable numbers. One food mass, weighing 124 grams, contained 221 worms. This figure does not include parasites that were loose in the stomach pouch and not embedded in the food mass. Although we made but the one count, it is our impression that this was not an extraordinarily heavy infestation. Cestode worms closely resembling *Dibothrium manubriforme* Linton (1889) were found in the posterior portion of the intestines of several specimens.

The concensus of opinion among guides and anglers in the Bay of Islands indicates that the kahawai (*Arripis trutta*) and piper (*Hemiramphus intermedius* Cantor) are the basic articles of diet for the striped marlin. It is particularly interesting, therefore, that our re-

sults show only one occurrence of *H. intermedius* in the stomachs. In view of this finding, it is probable that the schools of small fish on which marlin may be seen to feed, and which are assumed to be *H. intermedius*, are actually *Scomberesox saurus*.

From a qualitative point of view, it will be noted that the list of organisms found in the stomachs (Table I) includes ten species of fishes, representing nine families and three orders, and two species of cephalopods. These diverse forms indicate that in relatively shallow water (roughly 50 fathoms or less) the striped marlin feeds all the way from the surface to the bottom, wherever it may find suitable food. Even the most casual observation would suggest that the striped marlin must feed a great deal at the surface or in the middle depths. This is confirmed by the fact that about 90 percent of the individuals found in the stomachs represent species known to inhabit these regions. However, at least one of the species, *Pagrosomus auratus*, is quite strictly a bottom-dwelling form, showing that the striped marlin must also feed to some extent on or close to the bottom in shallow water. This conclusion is further supported by the work of Wallace and Wallace (1942), who found that the sand launce, *Ammodytes tobianus americanus* De Kay, was not uncommon in the stomachs of white marlin, *Makaira albida* (Poey), taken off the coast of Maryland. One of their specimens even contained an annelid worm, which must certainly have been taken very close to the bottom.

The bait most commonly used for marlin around the Bay of Islands is the kahawai, and it is certainly satisfactory. Good results are obtained with it and it is easy to procure, twenty minutes trolling around some of the rocks usually producing enough for one or two days of marlin fishing. The saury would doubtless be somewhat more difficult to obtain. However, if this difficulty could be overcome, the fact that the saury appears to be preferred nearly ten to one over the kahawai as food by the marlin at once raises the question as to whether it would be more effective as bait. This remains to be tested.

TABLE I

ANALYSIS OF THE STOMACH CONTENTS OF *M. mitsukurii*

Empty stomachs were not included in calculating "percent of occurrences"

Food item	Number	Percent	Av. No. per occurrence	No. of occurrences	Percent of occurrences
Scomberesox saurus	195	74.1	7.2	27	71
Arripis trutta	21	8.0	1.2	17	45
Pagrosomus auratus	13	4.9	1.9	7	18
Carangidae	9	3.4	2.2	4	11
Caesioperca lepidoptera	5	1.9	1.3	4	11
Allomycterus jaculiferus	2	0.8	2.0	1	3
Caprodon longimanus	1	0.4	1.0	1	3
Hemiramphus intermedius	1	0.4	1.0	1	3
Thyrsites atun	1	0.4	1.0	1	3
Caranx platessa	1	0.4	1.0	1	3
Unidentified fish flesh	..	..	..	10	26
Loligo sp.	13	4.9	1.6	8	21
*Argonauta sp.**	1	0.4	1.0	1	3

* Our thanks to Dr. Grace E. Pickford who kindly indentified this specimen.

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An Accessory Respiratory Device in Embryos of the Embiotocid Fish, *Cymatogaster aggregata*, during Gestation

C. L. Turner

Mature eggs of the viviparous embiotocid fish, *Cymatogaster aggregata* Gibbons, are fertilized in the ovarian follicles but are evacuated from them during segmentation stages into the ovarian cavity, where they undergo prolonged development. The embryos are born when they are from 34 to 38 mm. long (Eigenmann, 1894). The yolk supply is so scanty that it contributes little to the total nutritive requirements of the embryo during gestation. Nutritive materials are derived almost exclusively from the fluid of the ovarian cavity of the mother. Secretions from the cells lining the maternal ovarian cavity, and also fluid from the swollen ovary, contribute to the nutritive supply. The fluid is fortified also (Turner, 1938) by epithelial cells desquamated from the internal lining of the ovarian cavity and also by the remains of dead and partially absorbed embryos. The ovarian liquor enters the alimentary canals of the embryos by way of the mouths or opercular openings, and nutritive materials are absorbed from it by the intestine which is modified for the purpose.

Nitrogenous wastes and partially dehydrated residues from the alimentary canals of the embryos are discharged into the ovarian cavity in which the embryos are retained and live. Presumably the toxic compounds are absorbed through the vascular ovarian tissues of the mother and are eliminated by the maternal excretory organs.

The respiratory requirements of the early embryos are not great and apparently are met by the vascular portal system covering the body wall of the pericardial and peritoneal cavities. These portal systems are bathed by the maternal ovarian fluid. During later stages of development, there is an opportunity for exchange of oxygen and carbon dioxide between the gills of the embryo and the ovarian fluid as the fluid is drawn into the alimentary canal through the pharynx. Structures adapted for respiratory exchange are developed in the older embryos and appear as spatulate vascular expansions of the tissue at the margins of the dorsal and anal fins. These structures are lost near the close of the gestation period. An undescribed structural feature which facilitates respiration has been discovered in embryos ready for birth and is described in the following paragraph.

At the close of the period of gestation the embryos are closely packed within the ovarian cavity of the mother and are in contact with the ovarian walls or the ovarian ovigerous lamellae. In approximately one-half of the embryos, the opercular opening on one side has been invaded by a fold of tissue from the wall or one of the septa of the ovary to a depth of about 2 mm.

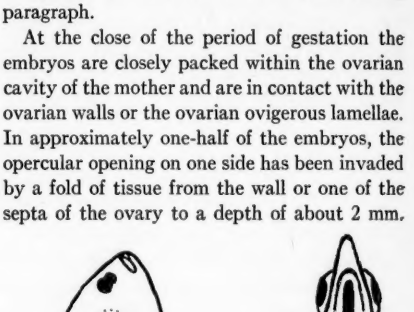

Fig. 1. Anterior end of unborn, 37-mm. embryo of *Cymatogaster aggregata* to show relationships of fold of ovarian tissue to operculum of embryo. A—Intact embryo with fold of maternal ovarian tissue inserted under right operculum. B—Ventral view of same embryo. Abbreviations: OV.T.—ovarian tissue; OP.—operculum.

(Fig. 1). The ovarian tissue is brought into direct contact with the gills on this side. The fold of invading tissue is thick and vascular and the opercular opening into which it protrudes is distorted (Fig. 1B), and in some cases the operculum is turned inward at the edges. No apparent differences were noted between embryos which possessed the structural feature and those which did not. The fact that only half of the embryos in a brood possessed the condition described and that all of the embryos of the brood appeared to be normal indicates that the condition is not essential for normal development and that it should be considered rather a facilitating mechanism.

The structural feature described is of particu-

lar interest because somewhat similar conditions exist in two other groups of fishes which harbor the embryos in the ovarian cavities during prolonged periods of gestation. In several species of the family Goodeidae the opercular openings of the embryos on one side or the other have wide apertures, and the tissue of the ovarian wall or septum comes into contact with the gills, but there is no growth of ovarian tissue into the opercular openings (Turner, 1940b). Accessory organs of respiration, the trophotaeniae, develop at an early stage and persist until the end of gestation in all species of Goodeidae except one. In *Jenynsia* (*Fitzroya*) *lineata* Günther the embryos are evacuated from the ovarian follicles into the ovarian cavity after the yolk supply has become exhausted; and almost immediately flattened, finger-like extensions grow out from the wall of the ovary and invade the opercular openings on one side of each embryo (Scott, 1928; Turner, 1940a). The condition becomes so extreme that the branchial and pharyngeal cavities become filled with the tissue and in some instances the tissue protrudes from the mouths of the embryos. It is assumed that the embryo depends entirely upon this structural relationship for its respiratory facilities and it is probable that nutritive materials also are obtained through the same device.

The conditions in goodeid, embiotocid and jenynsiid embryos represent cases of parallel adaptation. Viviparity has developed independently in these three groups of fishes and similarities are not dependent upon phylogenetic relationships. In all three, the embryos remain in the ovarian cavities for long periods and ovarian fluid is drawn into the alimentary canal through the opercular openings. Soft folds of ovarian tissue might be drawn into the opercular openings and the relations between ovarian tissue and embryonic gills would be ready for the extreme development which occurs in *Jenynsia*. The goodeid fishes, by the development of other structures (*trophotaeniae*) for embryonic respiration, are not under the necessity of developing further the gill-ovarian tissue contact. *Cymatogaster* had the possibility of developing further the gill-ovarian tissue contact during the early stages of gestation, but for most of the gestational period the respiratory function is shifted to the spatulate vascular extensions on the dorsal and anal fins. In late gestation, however, the structures upon the fin disappear and then for a short time the original relationship between ovarian tissue and embryonic gill is enlarged upon and in some of the embryos folds of ovarian tissue grow into the ovarian cavities.

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Observations on Chill Tolerance and Applied Chill Coma in Subtropical American Marine Fishes, Especially *Bathygobius*

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Parker (1939) drew attention to the advantages, especially for chromatophore studies, of cracked ice or ice water as a substitute for drugs in anesthetizing cold-blooded vertebrates. Various other investigators, including myself, have found this method useful for quieting animals for operative procedures.

Mortal susceptibility to chilling is a racial character well known in tropical and subtropical fishes (Allee et al., 1949: 99–102). Both field

records and experiments have established that temperatures well above freezing and above those at which many species of fishes thrive are fatally low for some other species (see Doudoroff, 1942, 1945, who cites all pertinent reports known to me except Gunter, 1945). Anyone working with exclusively warm-water species is, therefore, readily disposed to reject chilling as a method of general anesthesia lest it kill the fish.

How can one then immobilize a fish completely enough for photomicrographic time exposures without sacrificing it? If sufficient urethane, for example, is used to stop all respiratory movements, the fish dies. This dilemma confronting me while at the Lerner Marine Laboratory on North Bimini, in the Bahamas, B. W. I., impelled me to test the effects of short exposures to low temperatures on the common local goby, *Bathygobius soporator* (Valenciennes), first cautiously trying temperatures considerably higher than that of melting ice and then, as survivals belied misgivings, seeking the lower limit of tolerance to brief chilling. These experiments were a minor digression from other work and not intended as a thoroughgoing determination of the species' cold hardiness or lower thermal death point. Yet, as an extension of available information bearing on the thermal ecology and physiology of fishes, their outcome appears interesting enough to report here along with a few results of chilling certain other species and with further mention of practical applications of such results.

The tabulated data relate to *B. soporator* of both sexes and mixed sizes (4 to 8 cm. in total length) but presumably uniform in essential ecological character, as all were collected from a single habitat, the rock tide pools at Entrance Point (Breder, 1948; Tavolga, 1950), a mile south of the laboratory, in December, 1949, and January, 1950. Water temperatures were not taken there, but were determined periodically in the laboratory. Since the running sea water pumped from the bay was never observed to fall even briefly below 21.5°C. (though the air outside one night registered a season's minimum of 15°), the gobies' acclimatization temperature when collected could hardly have been significantly lower than the 23 or 24° which prevailed in the aquaria. On the other hand, the maximum temperatures they experienced not long before capture, especially on occasions of hiding in conch shells laid bare in the sun by the ebb tide, may easily have been higher. (During the summer, water temperatures of this tide-pool habitat range up to above 35°C.)

The usual test procedure was to transfer about four fish from the aquaria at about 23 or 24° directly into a 600-ml. beaker containing water (3 to 4 cm. deep) that was already cooled to the test temperature. The cooling agent consisted of refrigerator ice cubes melting in a lesser volume of sea water in a large culture bowl. By partly immersing the beaker and agitating it, sea water inside it could be cooled to nearly 0°C. in the warm laboratory, but for cooling below about 4° not to be unduly slow it was necessary to put a little ice also in the beaker. (The consequent dilution did the gobies no apparent harm; that it was, on the contrary, osmotically protective is suggested by Doudoroff's (1945) analysis of the lethal action of cold on other fishes.) The experimental temperature was kept essentially constant by watching the mercury in a partial-immersion thermometer used to stir the beaker's contents and appropriately removing the beaker from, and reimmersing it in, the cooling bowl; fluctuations generally did not exceed ±0.5° and for the most part cancelled each other by the end of each test period. At this time the fish were lifted out and as a rule put back directly into the aquaria of flowing sea water.

The behavior of *Bathygobius* plunged into cold water resembles that of *Fundulus heteroclitus* (Linnaeus) and *F. majalis* (Walbaum) transferred to ice water. There may at first be mixed manifestations of numbness and irritability. Almost always excited escape movements occur and are followed, sometimes after slow gasping, by often violent convulsions and quivering that ends in opisthotonic rigidity characterized by opercular and pharyngeal distention and by outspread protraction of the pectoral fins and erection of the dorsals. The tensely rigid state subsides after a minute or two, but at sufficiently low temperatures complete loss of spontaneous and reflex movement follows. This totally immobilizing chill coma is the "apparent death" (distinct from the "coma") described by Maurel and Lagriffe (1899). In my experiments its onset generally occurred within the first minute of chilling. As

the subjection to cold was never much prolonged, there was no good occasion to distinguish "primary" coma from final fatal immobilization, or "secondary" coma, or to observe the spontaneous resumption of breathing, etc., that may intervene between them (Doudoroff, 1945). On return to the relatively warm aquaria, some fish breathed and swam almost immediately, while others, reviving from deeper chilling, began to breathe, often fitfully, weakly, and uncertainly, only after remaining motionless for several minutes or as long as half an hour. In all the later, severer tests, artificial respiration was administered for half a minute or more between 5 and 15 minutes after removal from the cold. Leading a gentle stream of water through the mouth and past the gills and by its means effecting rhythmic passive exercise of the respiratory apparatus seemed the most effective way of facilitating and hastening recovery. Since both initiation and termination of chill coma depend upon a heat-transfer gradient, it is not surprising that smaller fish were generally the first in any group to sink into coma in cold water and that quickness of recovery at normal temperature showed some correlation with mildness of chilling.

Table I summarizes the data and results of 26 tests, which are presented, excepting the first, six and the tenth, in the order of increasing cold and lengthened subjection to it. Valid interpretation requires allowance for non-uniformity of size (not tabulated, because not systematically recorded) and of procedure. In any group comprising assorted sizes put to the same test, the larger members recovered; any that succumbed were smaller (though not always the smallest). The earlier tests were on mostly smaller fish and artificial respiration was applied in the best way only toward the end of the series. Most earlier failures of recovery should therefore be discounted in comparison with the last results, which show the effects of 0°C.

It appears, then, that the water temperature must be lowered to 0°C. before the median tolerance limit (Doudoroff, 1942) for 20-minute chilling is reached in *B. soporator* approximating 6 cm. in total length, when given some artificial respiration at about 10 minutes afterwards. For shorter periods of chilling, median tolerance of even subzero cold is indicated. No material qualification of these conclusions is necessitated by any possible acclimatizing effect of prior chilling (cf. Doudoroff, 1942, 1945), for the fish were kept unchilled no less than two days before each test and none had been previously chilled longer than 20 minutes nor more than twice.

After a number of tests had given assurance that the gobies could tolerate coma-inducing cold, if not too intense or prolonged, I put this means of immobilizing them to frequent practical use. When likewise applied to another population of the same species found along the bay shore north of the laboratory (cf. Tavolga, 1950), its results appeared the same as obtained with the Entrance Point tide-pool population. Both populations are included in the enumerations that follow, though few individuals came from the bay. A chilling in water at 5 to 6°C. for 7 or 8 minutes seemed best to combine strong effect with least risk. Following it, the gobies would remain motionless for further periods during which they were kept less cold but still below 10 or 15°; yet, provided this retention in less severe cold was limited to 10 to 20 minutes, they regularly revived, aided by artificial respiration, on return to running sea water. Thus, of 19 held wrapped in iced wet tissue for hypophysectomy after the usual cold treatment all, excepting two that suffered excessive surgical injury, swam again in due course; and 10 of them survived subsequent additional but briefer cold anesthesia. Also, 30 (including one of the above 19) were chilled 7 or 8 minutes at 5 to 6° and then kept immersed from 10 to 20 minutes in cold water for low-power photomicrography; and 14 of these were subjected to repetition of this treatment on other days, one of them even surviving five repetitions within two weeks. Only two of these 30 failed to revive from their extended chill comas. Furthermore, when 59 fish (including 12 of the afore-mentioned 30) were chilled briefly for not longer than 4 minutes at 3 to 8° to quiet them (more than once in several cases) for injections and nerve sections, every one recovered.

There was little indication that cold sufficient to excite convulsive stiffening and to bring on coma had more profound effects, as might be expected notwithstanding this record of recoveries. Chromatophore adaptation to either dark or pale backgrounds usually diminished after the initial chilling of two to many minutes'

duration, notably while the fish became rewarmed—sometimes the pigment shifted as far as half way from the fully dispersed or concentrated state characterizing the melanophores when best adapted to black or white, respectively—but within about an hour of revival, the pigmentary responses were normal. Some of the gobies chilled relatively long at 6° or colder temporarily failed to synchronize right and left sides when beginning to move their gills again. All of those deeply chilled remained subreactive for some time after re-establishing both equilibration and respiration. In one instance, after four were held at 6° for 20 minutes, one goby showed signs of partial paralysis, especially of the pectorals, that were not erased for a week.

TABLE I

SUMMARY OF TESTS OF THE ABILITY OF *Bathygobius soporator* TO RECOVER FROM TEMPORARY COMA-INDUCING (IMMOBILIZING) COLD

For explanations, see footnotes

Experiment No.	Date (1950)	1. Duration (minutes)	2. Temperature (°C.)	3. Water in beaker	4. No. of fish tested	5. No. recovered	6. Percent recovered	7. Time to coma (seconds)	8. Time to resume movement (minutes)
1–4	1 Jan.	⅔–3	9	s.w.	4 (0)	4	100	20–25	1–2
5	1 Jan.	5	9	s.w.	2 (0)	2	100	20–65	1–5
6	1 Jan.	10	9	s.w.	1 (0)	1	100	#	0–3
10	2 Jan.	2*	9	s.w.	5 (0)	5	100	20–40	<25
11	2 Jan.	20	12	½ i.w.	5 (0)	4	80	20–# #	0–1
17	5 Jan.	20	10	s.w.	4 (2)	4	100	30–# # #	0–<10
12	3 Jan.	10	8	s.w.	4 (2)	4	100	30–50	2–25
13	3 Jan.	10	7	s.w.	4 (2)	3	75	20–40	6–24
14 + 18	3, 6 Jan.	10	6	s.w.	8 (4)	7	87.5	20–40	7–22
20	6 Jan.	20	6	s.w.	4 (3)	3§	75	25–55	15–25
16	5 Jan.	10	5	s.w.	4 (2)	4	100	15–50	>20,<40
8	2 Jan.	10**	5	s.w.	5 (?)	2§§	40	20–25	22–32
7 + 24	1, 7 Jan.	2–5	4.5–6	¼–⅓ i.w.	3 (0)	3	100	<80	<10
15 + 19	5, 6 Jan.	10	4	s.w.	8 (4)	5	62.5	15–60	7–28
21	7 Jan.	20	4	s.w.	4 (4)	4	100	25–100	12–20
22	7 Jan.	20	3	s.w.	4 (4)	4	100	25–110	12–26
9	2 Jan.	4	2	⅓ i.w.	5 (?)	3§§	60	10–30	14–18
23	7 Jan.	11	2	⅓ i.w.	6 (6)	6	100	<60	<15
26	2 Feb.	10	0	⅓ i.w.	6 (0)	5	83.3		<35
25	2 Feb.	20	0	⅓ i.w.	6 (6)	3	50		25–35
Totals....	...	...	...	...	92(39–49)	76	82.6	...	...

Column 1. Duration means time, in minutes, during which fish remained in cold water..
Column 3. Fractions indicate approximate portions derived from ice (i.w.) diluting sea water (s.w.).
Column 4. Parenthetic numbers show how many of those tested had survived one or two prior tests (two or more days interval).
Column 7. Approximate time, in seconds, from immersion in cold water until cessation of all movements.
Column 8. Approximate time, in minutes, from return to aquarium (23 to 24°) until initial breathing movements.
* After the two-minute immersion in 9° water, kept moist and chilled (about 16°) for 15 minutes before return to normal aquarium.
** After the 10-minute immersion in 5° water, kept moist and chilled (12 to 15°) for five minutes before return to normal aquarium.
§ All four emerged from chill coma, but one died a few hours later.
§§ Besides those that completed recovery, one other resumed some movements before dying.
# Coma incomplete, interrupted occasionally by reflex movements.
# # Coma incomplete or fleeting, as reflex reaction to sharp tap on beaker persisted in one and as breathing or reflex movement recurred in three during second quarter of cold immersion; the first to cease moving did not survive.
# # # Coma not sustained, as reflex reaction in one and breathing in two recurred during second half of cold immersion.

With this single exception, all that survived any chilling acted wholly restored to normal within two hours of rewarming.

Thus, when used with due regard for the species' tolerance, iced water proved to be a useful substitute for anesthetics, even applied to a fish that in nature is restricted to tropical and subtropical seas. Slowing down metabolism, besides inducing immobility, it facilitated fairly protracted operations out of water. With almost no sacrifice of living fish it served to stop motion long enough for photomicrography with limited reflected light; slow posing, focussing, and time exposures, up to 20 seconds long for color film, were successful both with different individuals and with the same goby on different occasions.

Attempts by the same method to obtain color records of the tail of *Cyprinodon baconi* Breder succeeded also, but with more trouble because this species revived too easily even when more thoroughly chilled. After reacting like the gobies and similarly becoming inert in water colder than 6°C., they promptly quivered or even resumed breathing, unless kept iced and hardly warmer than 6 to 10° during the subsequent 10 to 20 minutes required to pose them in water under the dissecting binocular. When two fish were chilled and kept cold enough for such prolonged coma twice, with one day intervening, neither showed ill after-effects. This species, while probably less exposed to extreme temporary sun-warming, inhabits shallow water approximately as warm as the gobies' average habitat. But it is perhaps significant that this fish is very closely related to *C. variegatus*, which has a distribution extending north along the Atlantic coast to Cape Cod and which there is adapted to winter cold approaching 0°C.

The slippery dick, *Halichoeres bivittatus* (Bloch), which inhabits slightly deeper water and is accustomed to more stable environmental conditions, is less amenable to handling and less able to withstand rough treatment than *B. soporator* or *C. baconi*. It struggles violently whenever restrained. To avoid such difficulties in giving injections, eight slippery dicks, ranging from 10 to 16 cm. in total length and 10 to 48 gm. in weight, were chilled in sea water at 8°C. for about 3 minutes. They reacted just as did *Bathygobius* and sank into a coma; then, on return to flowing sea water at normal temperature, all but one recovered. Other individuals appeared to suffer no less from just being forcibly held for similar injections. Evidently the limit of tolerance to cold lasting 3 minutes was not reached at 8°C., some 13 degrees below the usual winter minimum of the Bimini habitat, and chill coma is applicable for some anesthetic use to this additional warm-water species.

Bathygobius soporator, which shows unexpected tolerance of cold, but, unlike *Cyprinodon baconi*, has no close congener in cold seas, is relatively resistant to other hardships. To what extent are the interspecific differences in cold hardiness characterizing various fishes correlated with differences in general ability to endure change in the physical and chemical environment or in special capacity to survive extreme deviation in some particular, such as oxygen tension, from their usual living conditions? An adequate answer must await the gathering of further comparative physiological and ecological data. Another unanswered question concerns susceptibility to chill coma. It is possible that the degree of difference between acclimatizing and chilling temperatures will prove to be a factor determining how easily or fully a fish can be immobilized reversibly by chilling. Past experience with *Fundulus heteroclitus* and *F. majalis* suggests that ice water may induce deeper and longer coma in summer than in winter, when the difference from the seasonally prevailing temperature is less. Recently certain sculpins collected in late April and May from the still-cold littoral waters of Monterey Bay, California, and then acclimatized[1] some weeks to only 14–17°C., proved to be more refractory than *Bathygobius* to cold anesthesia, for they could be chilled into nonfatal (but then not reliable or complete) coma for only about 5 minutes. Among five *Clinocottus analis* (Girard) from tide pools at Hopkins Marine Station, Pacific Grove, that were chilled in ice water at 1 to 2° for 3 minutes and then kept below 5°C., one never stopped twitching reflexly to the jarring of its glass container, and two recommenced breathing in from 10 to 12 minutes. While immersion for 21 minutes in ice and sea water at 0 to 3° was fatal to five of ten *Leptocottus armatus* Girard from the estuarine shallows of Elkhorn Slough, half of them (including

[1] Thanks to facilities and assistance accorded at Hopkins Marine Station by its director, Dr. L. R. Blinks, and his deputy, Dr. Rolf Bolin.

some that succumbed) quivered and twitched recurrently through the final 10 to 15 minutes of the chilling; and all of five others, when chilled 4 minutes at 1°, continued to react to smart tapping on their container and spontaneously resumed breathing in 10 minutes while kept at 4 to 5°C. Divergent results, viz. prolonged primary chill coma, obtained with *Leptocottus armatus* by Doudoroff (1945), may perhaps be accounted for, equally in accord with the suggestion offered above, by acclimatization to warmer water (which his brief footnote does not disaffirm).

Facilities were generously provided at the Lerner Marine Laboratory, a field station of the Department of Fishes and Aquatic Biology of The American Museum of Natural History. I am grateful to the staff for assistance and to all concerned for the hospitality shown me; I wish to thank especially the director, Dr. C. M. Breder, Jr.

Summary

Bathygobius soporator, *Cyprinodon baconi*, and *Halichoeres bivittatus*, all native to the tropical waters of Bimini in the Bahamas, can tolerate, within limits, chilling severe enough to induce coma.

The median tolerance limit of *B. soporator* acclimatized to about 23° is close to 0°C. for 20-minute chilling. *C. baconi* may be even more tolerant.

Totally immobilizng chill coma can be applied to these fishes for practical (e.g., photographic) purposes and can be prolonged equally or more successfully in *Bathygobius* than in some species adapted to cold seas.

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Pattern Variation and Evolution of the Mountain Kingsnake, *Lampropeltis zonata*

Richard G. Zweifel

THE considerable variation in the color pattern of *Lampropeltis zonata*, its extensive geographic range, and its somewhat less extensive ecologic range provide excellent material for a simultaneous study of both the geographic and ecologic aspects of variation. Throughout much of its range, *L. zonata* occurs in local montane populations. When represented by a sufficient number of specimens, the pattern variation of each of these populations has been subjected to statistical analysis and compared with the others; this pattern variation has been studied from the point of view of both ecologic and phylogenetic relationships.

Historical Summary

What may have been the first description of *Lampropeltis zonata* was that of Blainville (1835: 61) who described *Coluber zonatus* from California. However, the description of this form was so incomplete that, when the type specimen was lost, the species could no longer be identified with certainty.

The first name definitely associated with the

mountain kingsnake is *Bellophis zonatus* Lockington (1876: 52). Smith and Taylor (1945: 84) have reasoned that since Blainville's species is unidentifiable, Lockington is to be considered the author of the species, even though he apparently thought that he was merely placing Blainville's form in a new genus. A number of other authors have contributed to the discussion of the proper specific name for the mountain kingsnake (Burt, 1936; Peters, 1938; Klauber, 1943). The decision of Smith and Taylor, that *Lampropeltis zonata* (Lockington *ex* Blainville) is the proper name for the species, is followed in this paper. The form of citation is that of Smith and Taylor (1945: 84).

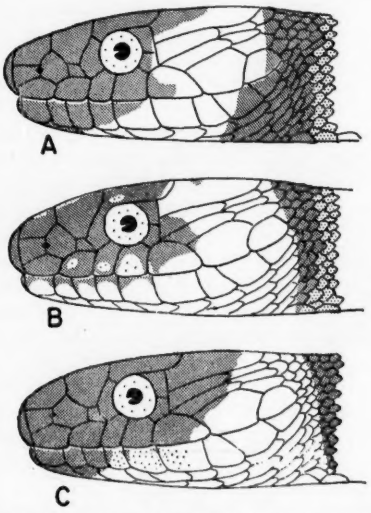


Fig. 1. Location of the first white ring in *Lampropeltis zonata:* A, Anterior position (*L. z. pulchra*); B, Intermediate position (*L. z. multifasciata*, Santa Cruz Mountains); C, Posterior position (*L. z. multicincta*).

Since the description of *Bellophis zonatus*, four more names have been proposed which are considered here to be applicable to distinct subspecies of the mountain kingsnake. These are *Ophibolus getulus multicinctus* Yarrow, 1882; *Coronella multifasciata* Bocourt, 1886; *Lampropeltis herrerae* Van Denburgh and Slevin, 1923; and *Lampropeltis agalma* Van Denburgh and Slevin, 1923. Two additional subspecies are described in this account.

Klauber (1943) reviewed the species and proposed the recognition of coastal and Sierran races, and in addition removed the Baja Californian forms *herrerae* and *agalma* from synonymy, treating them as races of the mountain kingsnake.

Pattern Variation

The basic color pattern of *Lampropeltis zonata* consists of a series of alternating white and black rings, commencing with a white ring on the back of the head (Pl. I). Most of the black rings enclose red areas laterally, and the red may expand across the dorsum so that red rings are formed within the black, splitting the black into two rings. Any black ring, split or not by red, and bordered on either side by white, is called a triad.

Variation in the amount of red is most obvious, and this formed the basis for the first systematic recognition of subdivisions within the species (Van Denburgh and Slevin, 1923; Klauber, 1943). Any increase in the amount of red on the body is always at the expense of the black, the white rings remaining at a relatively constant width. The amount of red on the body may be roughly indicated by determining the percentage of body triads that have the lateral red areas confluent dorsally, splitting the black; short of actually counting the number of red scales, no better method has been devised.

The number of triads on the body is subject to considerable variation, and forms another variable that has been studied.

The first white ring, crossing the posterior portion of the head, may be complete or may be interrupted mid-dorsally. More important is its position relative to the last supralabial scale. In the anteriormost position, the white ring is sufficiently far forward that its posterior margin lies on, or rarely anterior to, the last supralabial (Fig. 1A). At the other extreme, the posterior margin is behind the angle of the mouth and may be as far as four scales back, the whole band being placed to the rear (Fig. 1C). While the distances involved are small, the differences are so constant for different geographic areas that I am inclined to give this character more weight as an indicator of relationshps than is given to the other more highly variable characters. A third position of the first white ring is intermediate between the two extremes (Fig. 1B).

The color of the head scales anterior to the first white ring has been studied. In five of the races, these scales, the frontal, prefrontals and internasals in particular, are typically black; but in two races, there is commonly some light coloration, red in life, on these scales. Capitalized color names in the text have reference to Ridgway (1912) which was used as a standard for comparisons.

Comparison of the sexes with respect to pattern characters has disclosed no significant difference between them. In view of the small samples available from some areas, this has been an advantage in allowing pooling of the sexes for statistical treatment.

Variation in Scutellation

While this study has been primarily concerned with pattern variation, data on variaton in numbers of ventrals, subcaudals and scale rows are also included. The author is indebted to Dr. L. M. Klauber who very kindly made available the majority of the data upon which the scale variation summaries are based.

Accounts of Subspecies

Lampropeltis zonata multicincta (Yarrow)

Plate I, A

Ophibolus getulus multicinctus Yarrow (1882: 440), original description.
Lampropeltis zonata, Van Denburgh (1897: 167), part.
Lampropeltis pyrrhomelaena multicincta, Stejneger (1902: 153), part.
Lampropeltis multicincta, Blanchard (1920: 5), part.
Lampropeltis multicincta multicincta, Klauber (1943: 76), part.
Lampropeltis zonata multicincta, Klauber (1943: 76), part.

Type.—Adult female, No. 11753, United States National Museum, collected by Gustav Eisen. The type locality was given as Fresno, California, but it is probably from the Sierra Nevada to the east of Fresno.

Diagnosis.—Characterized by the following combination of characters: small amount of red on body, usually (90 percent of specimens) less than 60 percent of body triads dorsally split by red; first white ring in posterior position; snout black.

Variation in color pattern.—This diagnosis is based on 36 specimens. There are from 23 to 48 body triads, mean 35.88 ± 1.09. From none to 84 percent of the body triads are split dorsally by red, mean 25.08 ± 3.75. The first white ring is complete dorsally and in only one is the posterior margin as far forward as the angle of the mouth. The anterior head scales are normally black, without red markings. (Figs. 2–4; Table I.)

Color notes are available for a single specimen from Plumas County, California. The red of the triads of this snake was recorded as Carnelian Red (T. I. Storer, field notes).

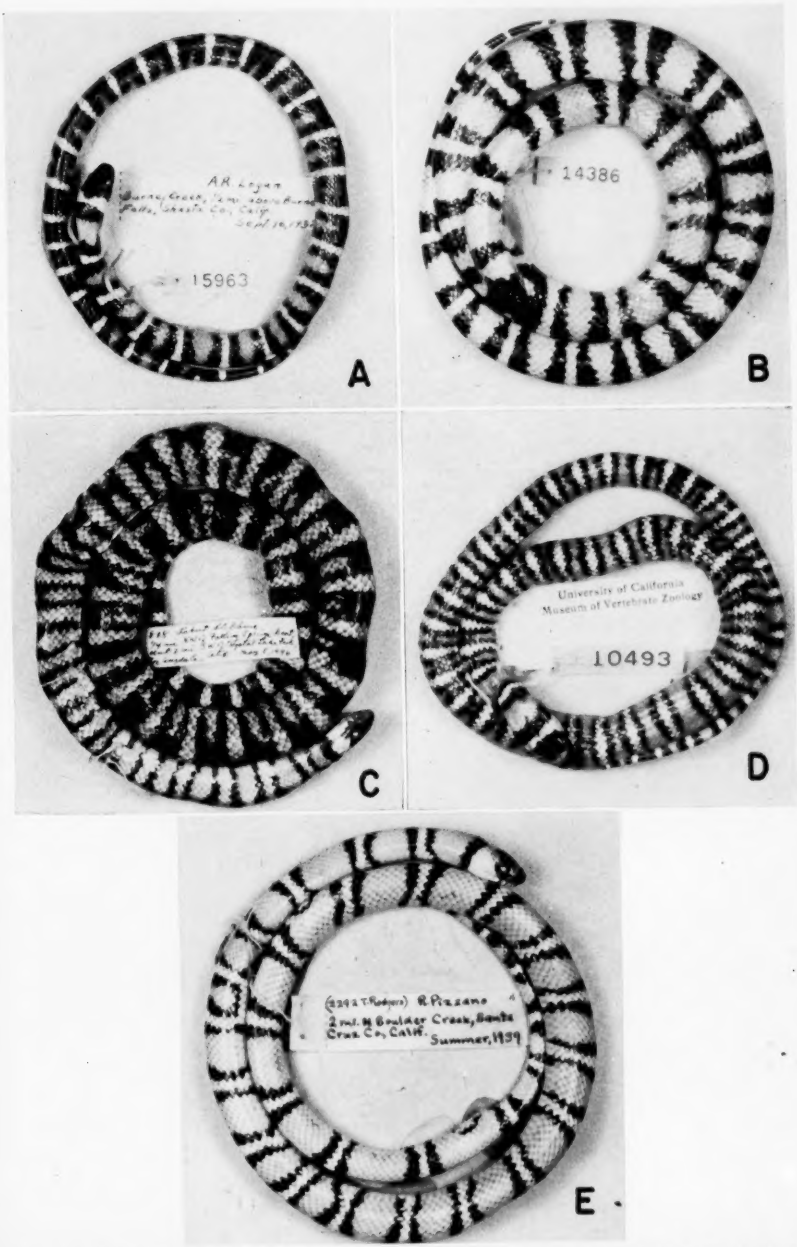
Variation in scutellation.—Eighteen males average 215.88 ± 1.16 ventrals, fourteen females, 216.28 ± 1.48. Nineteen males average 55.52 ± 0.68 subcaudals; thirteen females, 49.8 ± 0.81 (Table I). Close correspondence of the male and female ventral counts is evident, but the lower subcaudal counts of the females is correlated with their conspicuously shorter tails.

There seems to be a clinal trend in numbers of ventrals, the larger numbers being more common in the more southerly areas. Eight specimens, both males and females, from Tulare County average 221.4 ventrals. From the next county to the north, Fresno County, seven specimens average 217.7. Eleven specimens from the Yosemite region of Mariposa County, roughly in the center of the Sierra Nevada, average 213.6. This trend is continued into the region of intergradation with *L. z. zonata* in northern California and southern Oregon. Intergradation with that subspecies is discussed in the account of *L. z. zonata*.

A maximum of 23 dorsal scale rows is reached by 28 of 33 specimens, the others having 25 (2) and 21 (3).

Habitat.—The snakes of the Sierra Nevada seem to be restricted, or nearly so, to the yellow pine (*Pinus ponderosa*) belt. This situation has led to the supposition that the mountain kingsnake is a good indicator of the Transition Life-zone. Such may be true in the Sierra Nevada, but it is not so elsewhere.

Evidence seems to indicate that *Lampropeltis zonata* ranges little if any above the upper limits of the Transition Life-zone. A specimen (which I have not seen) from "Hot Springs, Long Canyon, Mt. Whitney, 8000′ " constitutes the highest altitude record for *L. z. multicincta*. That this record is not inconsistent with the assumption that this race reaches its approximate upper limit at the upper border of the Transition Life-zone is shown by the following



Lampropeltis zonata: A—*multicincta*, Shasta Co., Calif., MVZ 15963; B—*zonata*, Lake Co., Calif., MVZ 14386; C—*parvirubra*, type specimen, San Gabriel Mountains, Los Angeles Co., Calif., MVZ 42407; D—*agalma*, Sierra Juarez, Baja California, México, MVZ 10493; E—*multifasciata*, Santa Cruz Co., Calif., MVZ 32243.

statement: "The lower part of Long Canyon is in the Transition Zone. At this point a considerable number of trees and shrubs reach their upper limits. Among these are incense cedar, yellow pine, silver fir, sugar pine, pinon pine, white alder, canyon live oak, California black oak.... The lodgepole pine does not range below this altitude." (Elliot, 1904: 280).

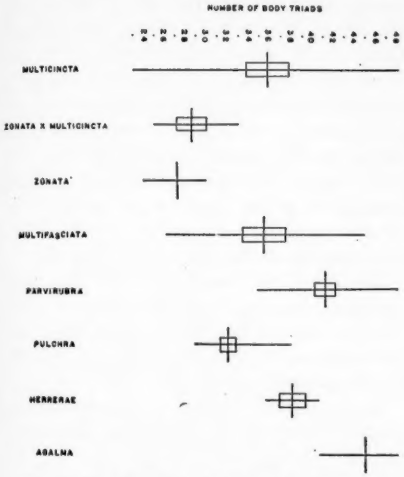


Fig. 2. Number of body triads in *Lampropelti zonata*. The short bar indicates the mean, th rectangle encloses two standard errors on each sid of the mean.

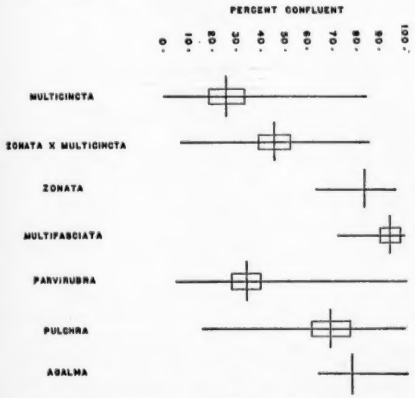


Fig. 3. Percentage of body triads dorsally split by red in *Lampropeltis zonata*. The short bar indicates the mean, the rectangle encloses two standard errors on each side of the mean.

DISTRIBUTION.—From eastern Shasta County, California, south along the western slopes of the Sierra Nevada at least to southern Tulare County and probably into northern Kern County (Fig. 5).

On the basis of the specimen from "Hot Springs, Long Canyon, Mt. Whitney, 8000′," Blanchard thought that *L. zonata* ranged east of the Sierran Divide. However, this locality is west of the divide, in the drainage of the Kern River, as is shown on the map of the collector's (Edmund Heller's) itinerary (Elliot, 1904). The eastern escarpment of the Sierra Nevada is very steep, and the area in which *L. zonata* might be expected to occur is in consequence quite restricted. *L. zonata* may yet be found in some of the deep, well protected canyons along the eastern slope.

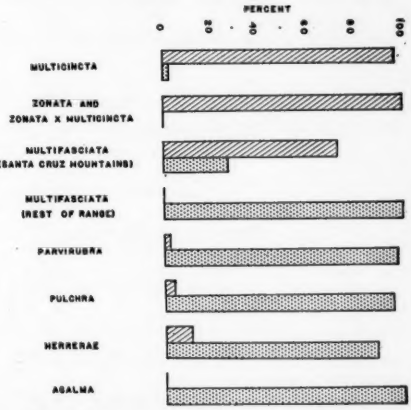


Fig. 4. Percentage distribution of the position of the first white ring in *Lampropeltis zonata*. Stipple = anterior position; diagonal lines = posterior.

LOCALITY RECORDS (ALL IN CALIFORNIA).—*Shasta County:* Burney Creek, 0.5 mi. above Burney Falls. *Plumas County:* Keddie, 6 mi. N of Gurnay; Butte (Butt) Valley, 1 mi. below Butte Lake Dam. *El Dorado County:* Riverton Post Office; Fyffe. *Calaveras County:* Wolfboro, 6000′. *Toulumne County:* Strawberry Lake, 5600′, 3 mi. E of Pine Crest. *Mariposa County:* Comet Mine, E of Mariposa; Tenaya Canyon; Yosemite Valley. *Fresno County:* 2.1 mi. SE of Pinehurst; 4 mi. W of Cedar Grove; 13 mi. from Cedar Grove; Kings River Canyon, 5000′. *Tulare County:* Smoky Valley, South Fork Kern River; Ash Mountain; Crystal Springs

Trail, Sequoia National Park; between Trout Meadows and Little Kern River; Whittaker's Forest, 10 mi. NE of Badger; General's Highway near Slide Spring, Sequoia National Park; Giant Forest.

Lampropeltis zonata zonata (Lockington *ex* Blainville)

Plate I, B

Bellophis zonatus Lockington (1876: 53), original description.
Lampropeltis zonata, Van Denburgh (1897: 167), part.
Lampropeltis pyrrhomelaena multicincta, Stejneger (1902: 153), part.
Lampropeltis multicincta, Blanchard (1920: 5), part.
Lampropeltis multicincta multifasciata, Klauber (1943: 76), part.
Lampropeltis zonata zonata, Klauber (1943: 76), part.

TYPE.—Formerly in the collection of the California Academy of Sciences, the type specimen (or specimens) was destroyed in the great fire of 1906. A personal communication from Van Denburgh was quoted by Blanchard (1921: 222): "the types . . . were two in number and were labeled Santa Barbara, but probably were collected in the mountains near there." Lockington cited the type locality as "Northern California." Reasons for rejecting Van Denburgh's statement in favor of the type locality cited by Lockington are given below.

DIAGNOSIS.—Anterior head scales dark; first white ring complete and in posterior position. Few body triads, 30 or less in four specimens examined; more than 60 percent of body triads dorsally split by red.

VARIATION IN COLOR PATTERN.—The four specimens upon which this race is based have 30, 28, 27 and 24 body triads. Respectively there are 90, 86, 63 and 96 percent of the triads split dorsally by red. (Figs. 2–3.) Despite this high percentage, these snakes are not so predominantly red as is *L. z. multifasciata* to the south. The posterior margin of the first white ring is from two to two and one-half scales back of the angle of the mouth. The anterior head scales are without light markings in all four specimens. (Figs. 2–4; Table I.)

VARIATION IN SCUTELLATION.—The four specimens, one male and three females, have 216, 207, 209 and 218 ventrals. Subcaudals are 52, 49, 49 and 46. Maximum scale rows are 23 in all specimens. (Table II.)

GEOGRAPHIC ALLOCATION OF THE TYPE SPECIMEN.—With respect to all pertinent characters, Lockington's description of *Bellophis zonatus* disagrees with specimens from the Santa Barbara region and agrees with specimens from north of San Francisco Bay.

Lockington's type had 32 white rings on the body and tail, therefore probably not more than 27 body triads. This agrees well with the condition observed in northern California specimens, but is ten triads fewer than the mean for seven snakes from Santa Barbara and Ventura counties and is well below the minimum of 35 exhibited by them. The type of *Bellophis zonatus*

TABLE I

BODY AND HEAD PATTERN CHARACTERISTICS OF *Lampropeltis zonata*

Subspecies	Number of specimens	Number of body triads	Percentage of body triads dorsally split by red	Position of first white ring	Snout color
multicincta	36	23–48 (35.9 ± 1.09)	0–84 (25.1 ± 3.75)	Posterior	Black
multicincta x *zonata* (intergrades)	9	25–33 (28.8 ± 0.70)	6–85 (45.3 ± 3.3)	Posterior	Black
zonata	4	24–30 (27.2)	63–96 (83.8)	Posterior	Black
multifasciata	22	26–45 (35.4 ± 0.96)	72–100 (93.9 ± 2.2)	Intermediate and anterior	Red present
parvirubra	61	35–48 (41.2 ± 0.44)	4–100 (33.9 ± 2.6	Anterior	Black
pulchra	50	27–38 (32.2 ± 0.38)	15–100 (69.2 ± 2.8)	Anterior	Black
agalma	4	41–48 (45.0)	63–100 (77.3)	Anterior	Red present
herrerae	10	36–41 (38.2 ± 0.63)	(0.0)	Anterior	Black

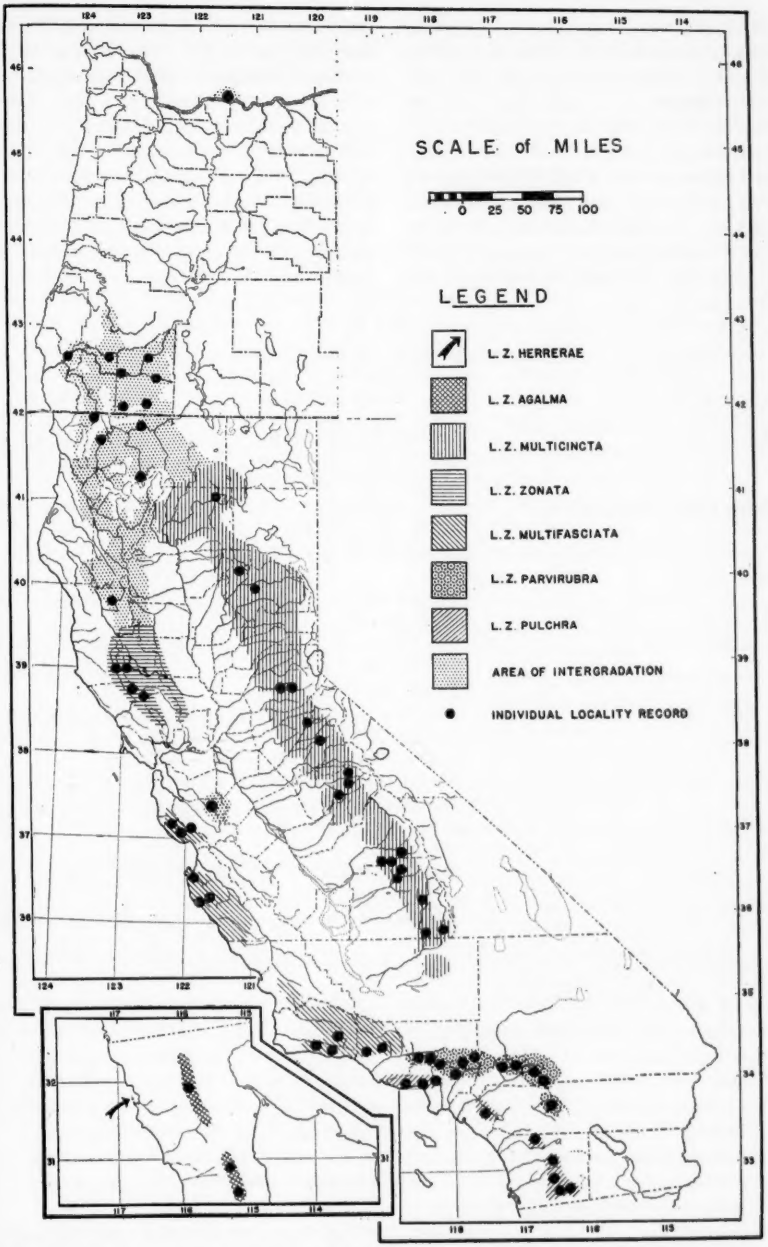


Fig. 5. Distribution and locality records of *Lampropeltis zonata*. The estimate of total range was derived from personal observation, data accompanying specimens, and pertinent literature (Grinnell,9 135; Bailey, 1936; Jansen, 1947).

had a black snout, while all seven specimens from Santa Barbara and Ventura counties have some light markings anterior to the first white ring. More important, however, is the position of the first white ring. In the southern California snakes, the ring is in the anterior position. While Lockington did not specifically relate the position of the ring to the supralabials, he did mention that the first black ring commences *back* of the parietals, which indicates that the white ring was well back on the head, as is typical of the northern snakes. Lockington further states that "the black rings become wider on the center of the back, approaching, and in most cases, joining each other in pairs." It seems probable that if the type did come from northern California, it came from the area of intergradation between *L. z. zonata* and *L. z. multicincta*, so the assignment of the name *zonata* to the more westerly race is somewhat arbitrary.

TABLE II

VENTRAL AND SUBCAUDAL SCALE COUNTS OF THE RACES OF *Lampropeltis zonata*.

Subspecies	Ventrals	Subcaudals
multicincta	18♂, 202–225 (215.88 ± 1.16)	19♂, 49–61 (55.52 ± 0.68)
	14♀, 209–227 (216.28 ± 1.48)	13♀, 46–55 (49.84 ± 0.81)
	All, 202–227 (216.06 ± 0.95)	
multicincta x *zonata* (intergrades)	9♂, 203–214 (208.44 ± 1.47)	9♂, 49–54 (51.40 ± 0.51)
	3♀, 210–211 (210.33)	3♀, 46–48 (46.33)
	All, 203–214 (209.08 ± 1.11)	
zonata	1♂, 216	1♂, 52
	3♀, 207–218 (211.3)	3♀, 46–49 (48.0)
	All, 207–218 (212.5)	
multifasciata	9♂, 205–219 (211.33 ± 2.2)	8♂, 55–61 (58.12 ± 0.69)
	8♀, 206–224 (208.2 ± 3.0)	8♀, 52–62 (52.29 ± 2.1)
	All, 205–224 (209.88 ± 1.68)	
parvirubra	19♂, 204–220 (212.24 ± 1.01)	17♂, 54–60 (56.70 ± 0.53)
	25♀, 204–216 (209.72 ± 0.71)	24♀, 48–56 (53.54 ± 0.56)
	All, 204–220 (211.02 ± 0.65)	
pulchra	16♂, 198–210 (206.43 ± 1.02)	15♂, 51–59 (55.2 ± 0.72)
	18♀, 194–220 (205.11 ± 1.63)	16♀, 47–58 (52.44 ± 0.87)
	All, 194–220 (205.73 ± 0.96)	
agalma	1♂, 213	1♂, 56
	3♀, 207–210 (208.6)	3♀, 50–55 (52.3)
	All, 207–213 (209.7)	
herrerae	8♂, 217–220 (218.7 ± 0.42)	7♂, 57–59 (58.28 ± 0.38)
	1♀, 216	1♀, 53

INTERGRADATION WITH OTHER SUBSPECIES.—Ten specimens from southwestern Oregon and northern California have been available, some with the typical pattern of *L. z. zonata* and some typical of *L. z. multicincta*. As these two races have been defined, *multicincta* typically has less than, and *zonata* more than, 60 percent of the body triads dorsally split by red. This plainly allows no room for intermediacy on the part of individuals, but a comparison of the ranges of variation and means of the populations in question shows that, as a whole, the northern California and Oregon snakes stand roughly intermediate (Figs. 2–3). The zone of intergradation evidently extends from northern Mendocino County, California, into the Rogue River Valley of Oregon and east throughout the Siskiyou region in California. Within the area outlined, there is no consistent geographic arrangement of the two pattern types evident in the material available. (An explanation for this situation is offered in a subsequent section on dispersal and evolution.)

The five northernmost specimens, from Klickitat County, Washington, represent a similar situation, both pattern types being represented.

HABITAT.—There seem to be no published data on the habitat of this subspecies. One of the localities, four miles southwest of Lakeport, Lake County, California, is in the chaparral zone.

DISTRIBUTION.—Specimens are known from the mountains of Napa, Lake, southern Mendocino and Sonoma counties in west-central California (Fig. 5).

LOCALITY RECORDS.—*Mendocino County:* Hopland. *Napa County:* Mount Saint Helena. *Sonoma County:* Near The Geysers. *Lake County:* 4 mi. SW of Lakeport.

LOCALITIES IN THE ZONE OF INTERGRADATION. —CALIFORNIA.—*Siskiyou County:* Callahan; Beaver Creek, mouth of Dutch Creek; Klamath River, mouth of Clear Creek. *Del Norte County:* East Fork, Illinois River, ¼ mi. S of Oregon State Line. *Mendocino County:* near Covelo. OREGON.—*Jackson County:* Little Applegate River, 7 miles above mouth; 7 mi. SE of Brownsboro; McLeod; Rogue River; 4 mi. S of Ashland. *Josephine County:* near Wolf Creek. *Curry County:* 3 mi. N of Illahe; W side Rogue River, 3 mi. above Agness. WASHINGTON.— *Klickitat County:* 1 mi. W of White Salmon; Bingen.

Lampropeltis zonata multifasciata (Bocourt)

Plate I, E

Coronella multifasciata Bocourt (1886: 616), original description.
Coronella zonata, Boulenger (1894: 202).
Lampropeltis zonata, Van Denburgh (1897: 167), part.
Lampropeltis pyrrhomelaena multicincta, Stejneger (1902: 153), part.
Lampropeltis multicincta, Blanchard (1920: 5), part.
Lampropeltis multicincta multifasciata, Klauber (1943: 76), part.
Lampropeltis zonata zonata, Klauber (1943:76), part.

TYPE.—In the Paris Museum, collected in California by M. de Cessac.

DIAGNOSIS.—Large amounts of red on body and on anterior head scales, particularly prefrontals, characterize this subspecies. The only other race regularly having red on snout, *L. z. agalma* of Baja California, has 41 or more body triads. There are less than this number in 19 of 21 specimens of *L. z. multifasciata*.

VARIATION IN COLOR PATTERN.—Twenty-two specimens of this race have been examined. The body triads range in number from 26 to 45, mean 35.4 ± 0.96. The great amount of red on the body is reflected in the percentage of body triads split dorsally; range 72–100 percent, mean 93.9 ± 2.2. There are red markings in the snout region in 17 of 19 specimens checked for this character. (Figs. 2–4; Table I.) The position of the first white ring varies geographically. In the northern specimens, from the Santa Cruz Mountains, the posterior margin of the ring is near the rear edge of the last supralabial or on the scale following it, so that the condition for the population as a whole is intermediate between the anterior and posterior positional extremes. All specimens of *L. z. multifasciata* from south of Monterey Bay have the ring in the anterior position.

While the greatest number of body triads for this race was recorded for a rather northerly locality (Carmel Highlands, Monterey County), there seems to be a trend toward higher triad counts at the southern end of the range in Santa Barbara and Ventura counties. Ten snakes from the Santa Cruz Mountains have an average of 32.6 ± 1.28 body triads (range 26–38), while seven specimens from Santa Barbara and Ventura counties have from 35 to 43 triads, mean 37.6 ± 1.0.

The specimens from Santa Barbara and Ventura counties have, on the average, less red on the anterior head scales than is usual in the more northerly snakes. This represents an approach to the forms of southern California south of Ventura County.

Color notes are available for two living individuals of this race, both from the Santa Cruz Mountains. The red areas of one specimen were near English Red dorsally and Grenadine Red ventrally (Thomas Rodgers, field notes). In the other specimen, the areas were between English Red and Grenadine Red. The notes on the latter specimen were taken shortly after it had shed. Many of the scales in the white rings of this snake were tipped with gray.

VARIATION IN SCUTELLATION.—Nine males have from 205 to 219 ventrals, mean 211.33 ± 2.2. Eight females average 208.2 ± 3.0, range 206–224. Males average 58.12 subcaudals, females 52.29. The range of the females (52–62) completely overlaps that of the males (55–61). (Table II.)

INTERGRADATION WITH OTHER SUBSPECIES.— A single specimen from Mount Hamilton, Santa Clara County, has been interpreted as an inter-

grade between *L. z. zonata* and *L. z. multifasciata*. This individual has a black snout, but light markings are present on the supraoculars. The first white ring is in the posterior position, agreeing in this respect with *L. z. zonata*. All the body triads are widely split by red. This specimen is unique among all mountain kingsnakes examined in that it possesses only 19 body triads. In the sum of its characters, it appears nearer to *L. z. zonata*, despite its closer geographic proximity to *L. z. multifasciata*.

It is possible that other small endemic populations of kingsnakes await discovery in the area surrounding San Francisco Bay, and that they may prove subspecifically distinct.

GEOGRAPHIC ALLOCATION OF THE TYPE SPECIMEN.—Bocourt's (1886) figure of the type clearly shows a considerable amount of light color in the snout region. The difficult accessibility of the range of the only other light-snouted race, *L. z. agalma* of Baja California, together with the type locality cited for *L. z. multifasciata* ("Californie"), favors the assignment of Bocourt's name to the California subspecies.

HABITAT.—The Big Basin area of the Santa Cruz Mountains, where a number of specimens have been taken, is the site of one of the most extensive redwood forests south of San Francisco Bay. Farther south, in the Santa Ynez Mountains of Santa Barbara County, the snakes live in chaparral where the mountains closely approach the ocean.

DISTRIBUTION.—The southern limit is reached in the mountains of Ventura and Santa Barbara counties, California. The Santa Clara River forms the dividing line between *L. z. multifasciata* and the races to the south. There is a gap of over 150 miles to the nearest records to the north, in Monterey County. It is probable that future collecting will only partly bridge this gap, as much of the intervening territory appears to be unsuited to this species. There is little doubt that the population of the Santa Lucia Mountains in Monterey County is completely disjunct from that of the Santa Cruz Mountains north of Monterey Bay. The northern extremity of the range is in the Santa Cruz Mountains of Santa Cruz and Santa Clara counties (Fig. 5).

LOCALITY RECORDS.—All in California. *Santa Clara County:* Wright's Station. *Santa Cruz County:* Near Zayante; Big Basin State Park; Ben Lomand; Boulder Creek (also 2 mi. W; 2 mi. N); Santa Cruz (also 2 mi. N). *Monterey County:* Fern Canyon Road, Carmel Highlands; Pine Valley, head of Carmel River; Big Sur. *Santa Barbara County:* Bluff Camp, 4500′; summit San Marcos Pass; San Marcos Ranch; Mono Flat, 8 mi. NE of Santa Barbara; Santa Ynez Grade, 4 mi. S of Santa Ynez. *Ventura County:* Matilija; Red Reef Canyon, 16 mi. NE of Ojai.

Lampropeltis zonata parvirubra, subsp. nov.

Plate I, C

Lampropeltis zonata, Van Denburgh (1897: 167), part.
Lampropeltis pyrrhomelaena multicincta, Stejneger (1902: 153), part.
Lampropeltis multicincta, Blanchard (1920: 5), part.
Lampropeltis multicincta multicincta, Klauber (1943: 76), part.
Lampropeltis zonata multicincta, Klauber (1943: 76), part.

TYPE.—Adult male, No. 42407, Museum of Vertebrate Zoology, collected by Robert C. Stebbins on May 8, 1946, ¼ mi. NW of Falling Springs Resort, 2 mi. SW of Crystal Lake Park, San Gabriel Mountains, Los Angeles County, California.

DESCRIPTION OF TYPE SPECIMEN.—Snout-vent length 590 mm., tail length 118 mm.; 212 ventrals, 57 subcaudals; dorsal scale rows 21-21-17; supralabials 7/7, infralabials 9/9. Forty-three body triads, of which five (11.6 percent) are split dorsally by red. The first white ring is incomplete dorsally with the posterior margin on the last supralabial. The dorsal surface of the head anterior to the first white ring is black.

DIAGNOSIS.—The combination of characters that distinguishes this race from the others is as follows: first white ring in anterior position; high triad count, 37 or more in 90 percent of specimens; snout dark; relatively little red on body.

VARIATION IN COLOR PATTERN.—Sixty-one specimens exhibit the following variation: body triads 35–48, mean 41.16 ± 0.44; percentage body triads with red dorsally confluent, 3.5–100, mean 33.9 ± 2.64. Three specimens have the posterior margin of the first white ring one-half scale back of the angle of the mouth; the

rest have it on the last supralabial scale. (Figs. 2–4; Table I.)

Color notes have been taken from three living specimens of this subspecies, all from the San Gabriel Mountains of Los Angeles County, California. The red of the anterior rings of one specimen was between Flame Scarlet and Mars Orange; the posterior rings were closer to Flame Scarlet. Two other specimens had almost identical colors, anterior rings between Scarlet and Brazil Red, posterior rings slightly deeper. *L. z. parvirubra* seems to resemble the other southern Californian race, *L. z. pulchra*, more closely than it does *L. z. multicincta* with respect to the shade of red.

VARIATION WITHIN A SINGLE BROOD.—Through the courtesy of Dr. L. M. Klauber, I have been able to examine a brood of eight snakes hatched from eggs laid at the San Diego Zoo by a snake from Seven Oaks, San Bernardino Mountains. The body pattern of the father is unknown; that of the mother is decidedly unusual for this subspecies. She has the greatest amount of red on the body of all *parvirubra* examined, and has a triad count only one above the minimum recorded for the race. The brood differs from the mother in varying degrees (Fig. 6), showing a correlation of low triad count with increased red, as well as the converse.

VARIATION IN SCUTELLATION.—Nineteen males average 212.24 ± 1.01 ventrals, range 204–220; 25 females average 209.72 ± 0.71, range 204–216. The absence of significant differences in numbers of male and female ventrals noted for other subspecies is again suggested. Males average 56.70 ± .53 subcaudals, females 53.54 ± .56. (Table II.) Thirty-three specimens have a maximum of 21 scale rows, eight have 23 scale rows. In number of scale rows, *L. z. parvirubra* differs from *L. z. multicincta* which usually has 23 as the maximum, and which superficially resembles *parvirubra* in body pattern.

INTRASUBSPECIFIC TRENDS.—While only 13.5 percent of the snakes from the San Bernardino Mountains have the first white ring interrupted, it is broken dorsally in 45 percent of the specimens from the San Gabriel Mountains of Los Angeles County. This seems to be a tendency toward the condition in the snakes of the coastal Santa Monica Mountains (*L. z. pulchra*) where 81 percent of 18 specimens have the ring broken.

Seven specimens from the San Jacinto Mountains, Riverside County, have an average of 38.4 body triads, 2.8 fewer than the mean for the race as a whole. In addition the San Jacinto snakes average fewer ventrals than the race as a whole, 206.25 as contrasted to 211.02 for all males and females. Both of these trends are in the direction of *L. z. pulchra*. Larger numbers of specimens might prove it better to recognize the snakes of the San Jacinto Mountains as intermediate between *pulchra* and *parvirubra*.

HABITAT.—The altitudinal range is from about 1000 to 9000 ft., the lower extreme being

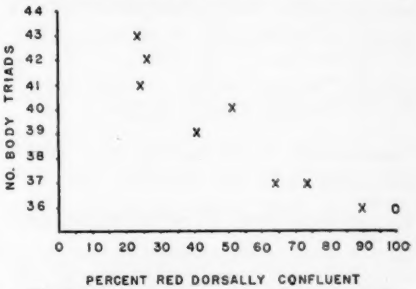


Fig. 6. Pattern characteristics of *L. z. parvirubra*, mother (O) and brood (X).

reached along the southern face of the San Gabriel Mountains, Los Angeles County, California, and the higher extreme in the San Jacinto Mountains, Riverside County. At higher altitudes it is commonly associated with yellow-pine (*Pinus ponderosa*) and incense cedar (*Libocedrus decurrens*). At lower elevations big-cone spruce (*Pseudotsuga macrocarpa*) and various canyon chaparral species are common associates. Records for altitudes above 6000 ft. are scarce. From the Lake Arrowhead region of the San Bernardino Mountains, elevation 4000–5500 ft., ten specimens have been available, but from nearby Big Bear Lake, elevation 6700 ft., which is also a popular collecting and resort site, none has been reported.

DISTRIBUTION.—Found in the San Gabriel, San Bernardino and San Jacinto mountains in southern California (Fig. 5).

LOCALITY RECORDS.—All in California. *Riverside County* (San Jacinto Mountains): Strawberry Valley; Idyllwild; Mt. San Jacinto, 9000′;

Fern Valley. *San Bernardino County* (San Bernardino Mountains): Cable Canyon near Verdemont; 1 mi. E of Cedar Pines Post Office; Crestline; near Thousand Pines; Blue Jay; Lake Arrowhead; Santa Ana River, 5600′; Barton Flats; Forest Home; Seven Oaks; Water Canyon near Banning (may be in Riverside County); Whitewater Wash, 6000′; (San Gabriel Mountains) Lytle Creek, 6000′. *Los Angeles County* (San Gabriel Mountains): Head of Mescal Gulch, Pig Pines; Swartout; ¼ mi. NW of Falling Springs Resort; Monrovia Canyon; mouth Arroyo Seco Canyon; Arroyo Seco Canyon; Monrovia Peak; Santa Anita Canyon; Altadena; Bell Canyon; Bailey Canyon; Wintergreen Canyon; Fish Canyon; Mount Wilson; West Fork San Gabriel River, 1.0 mi. E of Red Box Divide; Glendora; La Cañada; Eaton Canyon; Big Tujunga Canyon; Pacoima Canyon; Placerita Canyon; 2 mi. S of Newhall.

Lampropeltis zonata pulchra, subsp. nov.

Lampropeltis zonata, Van Denburgh (1897: 167), part.
Lampropeltis pyrrhomelaena multicincta, Stejneger (1902: 153), part.
Lampropeltis multicincta, Blanchard (1920: 5), part.
Lampropeltis multicincta multifasciata, Klauber (1943: 76), part.
Lampropeltis zonata zonata, Klauber (1943: 76), part.

TYPE.—Adult male, No. 38667 in the collection of Laurence M. Klauber, collected near Crater Camp, Santa Monica Mountains, Los Angeles County, California. Crater Camp lies at an altitude of 450 ft., about 10 miles WNW of the city of Santa Monica.

DESCRIPTION OF THE TYPE SPECIMEN.—Snout-vent length 545 mm., tail length 101 mm.; 217 ventrals, 57 subcaudals; dorsal scale formula 21-21-17; supralabials 7/7, infralabials 9/9. Thirty-two body triads, of which 22 (68.7 percent) have the lateral red areas dorsally confluent. The first white ring is incomplete dorsally with the posterior margin on the last supralabial. The anterior head scales are dark, except for a small white fleck on the frontal.

DIAGNOSIS.—Distinguished by the following combination of characters: no red on snout; fewer than 39 body triads; first white ring in anterior position; relatively large amount of red per triad.

VARIATION IN COLOR PATTERN.—There are from 27 to 38 body triads, the mean for the 50 specimens being 32.24 ± 0.38. There is considerable variation in the amount of red on the body, from 15 to 100 percent of the triads being split dorsally. The mean for this character is 69.16 ± 2.8 percent.

Color notes are available for three living specimens. An individual from the Santa Monica Mountains had red areas which were Dragon's Blood Red anteriorly and Brazil Red toward the tail. Another from the Santa Monica Mountains was Brazil Red in both the anterior and posterior rings. Klauber (1943: 80) records a snake from San Diego County which had Scarlet rings anteriorly and Brazil Red toward the tail. The white rings tend toward Cream color.

The first white ring may be complete or may be broken along the mid-dorsal line. In the Santa Monica Mountains of Los Angeles County, 81 percent of 18 specimens have the ring broken, while to the south in San Diego County the incidence of incomplete rings is about 60 percent. In only one of 50 specimens is the posterior margin of the first white ring behind the angle of the mouth, and in that one it is only one-half scale back. (Figs. 2–4; Table I.)

VARIATION IN SCUTELLATION.—As in other races, there is no significant difference between the male and female ventral counts. Males average 206.43 ± 1.02, females 205.11 ± 1.63. *L. z. pulchra* has the lowest average ventral count of any of the races of *zonata*, but the overlaps are too extensive to permit the use of the scale counts as a key character. In subcaudals, males average 55.2 ± 0.72, females 52.44 ± 0.87. Twenty of 33 specimens have 21 dorsal scale rows, 13 have 23 rows. (Table II.)

HABITAT.—The altitudinal range is from within a few feet of sea level to over 5000 feet. Where the maximum elevation is attained, in San Diego County, the snake probably does not range below 4000 feet. To the north, in the Santa Monica Mountains, the range extends from about 3000 feet (the maximum elevation of the mountain range) to within a few feet of sea level at the mouths of the larger canyons.

In the Santa Monica Mountains the plant associates are typical of canyons in the chaparral: *Quercus agrifolia*, *Platanus racemosa*, *Juglans californica*, *Rhus ovata*, *Rhus laurina* and *Rhus diversiloba*. In the mountains of San

Diego County this subspecies apparently ranges little if any below the yellow pine (*Pinus ponderosa*) belt.

DISTRIBUTION.—Known from the Santa Monica Mountains, Verdugo Hills, Santa Ana Mountains and the mountains of San Diego County in southern California (Fig. 5).

LOCALITY RECORDS.—*Los Angeles County* (Santa Monica Mountains): Saddle Peak; Crater Camp; Topanga Canyon; Pacific Palisades; Rustic Canyon; Stone Canyon; Beverly Glen Canyon; Mulholland Drive; Griffith Park; (Verdugo Hills) Glendale. *Orange County:* Santa Ana Mountains, Santiago Canyon; 2 mi. S of Irvine. This latter locality is not in the mountains, but is on the coastal plain, well out of the usual habitat. Perhaps the specimen is a flood-transported waif. *San Diego County:* Palomar Mountain; Iron Spring, Palomar Mountain; Laguna Junction; Laguna Mountain; Julian; Pine Hills; Green Valley; Cuyamaca Mountain; Guatay; Pine Valley.

Lampropeltis zonata agalma Van Denburgh and Slevin

Plate I, D

Lampropeltis agalma Van Denburgh and Slevin (1923: 2), original description.
Lampropeltis zonata, Linsdale (1932: 378).
Lampropeltis multicincta agalma, Klauber (1943: 76).
Lampropeltis zonata agalma, Klauber (1943: 76).

TYPE.—Adult male, No. 56856, California Academy of Sciences, collected by J. R. Slevin, June 16, 1923 at an altitude of 7000 feet near Alcatraz, Sierra San Pedro Martir, Baja California, México.

DIAGNOSIS.—The combination of a high triad count, more than 40 on the body, considerable red on the body, and red on the snout is characteristic of this race and only rarely occurs in one other, *L. z. multifasciata*.

VARIATION IN COLOR PATTERN.—The four specimens of this race have 41, 45, 46 and 48 body triads. These snakes have respectively 100, 80, 63 and 66 percent of the body triads dorsally split by red. The first white ring is incomplete in three of them, and is the anterior position in all. (Figs. 2–4; Table I.)

VARIATION IN SCUTELLATION.—The four specimens have an average of 209.75 ventrals. The single male has 56 subcaudals; the three females, 50, 52 and 55. (Table II.)

HABITAT.—The specimens are from high altitude yellow pine forests, 5400 to 7000 feet in elevation.

DISTRIBUTION.—High altitudes of the Sierra Juarez and Sierra San Pedro Martir in northern Baja California, México. The specimen from the Sierra Juarez was considered by Klauber (1943: 79) to be an intergrade with *L. z. pulchra* to the north, but since it has the highest triad count of the four and has more red than the southernmost specimen of *agalma*, it is considered here as *agalma*.

LOCALITY RECORDS.—*Baja California, del Norte:* (Sierra Juarez) Laguna Hansen, 5400 feet; (Sierra San Pedro Martir) Alcatraz, 7000 feet; Valladares Creek; Santa Eualia.

Lampropeltis zonata herrerae Van Denburgh and Slevin

Lampropeltis herrerae Van Denburgh and Slevin (1923: 2), original description.
Lampropeltis multicincta, Stejneger and Barbour (1943: 148), part.
Lampropeltis multicincta herrerae, Klauber (1943: 76).
Lampropeltis zonata herrerae, Smith and Taylor (1945: 84).

TYPE.—Adult male, No. 56856, California Academy of Sciences, collected by J. R. Slevin on South Todos Santos Island, Baja California, México, May 23, 1923.

DIAGNOSIS.—Distinguished from almost all mainland snakes by the lack of red in the pattern. From the occasional black and white *L. z. multicincta*, the snakes of South Todos Santos Island are distinguished by the position of the first white ring, the posterior margin of which is rarely back of the angle of the mouth, whereas it is in the posterior position in the Sierran snakes.

VARIATION IN COLOR PATTERN.—There is almost complete suppression of red, that color being represented by brownish patches laterally placed on some of the anterior triads. In ten specimens, the number of body triads ranges from 36 to 41, mean 38.2 ± 0.63. The first white ring tends to be a little farther back on the head than in the other southern races, but in only one specimen is the posterior margin as far back as one-half scale behind the angle of the mouth. (Figs. 2–4; Table I.)

VARIATION IN SCUTELLATION.—Eight males average 218.7 ± 0.42 ventrals, the single female has 216. The males have from 57 to 59

subcaudals, mean 58.28 ± 0.38, the female has 53. All have a maximum of 23 dorsal scale rows, a condition not in line with the usual reduction in scale rows in more coastally located areas. (Table II.)

HABITAT.—South Todos Santos Island is one and one-quarter miles long, has a maximum altitude of 313 feet, and is covered with low brush and cactus. The specimens collected by Mr. Slevin were abroad on a cloudy day. Probably abundant fogs are an important factor in permitting the existence of this species at such a low altitude and latitude.

DISTRIBUTION.—This race appears to be restricted to the type locality, South Todos Santos Island, which is three miles from the tip of Punta Banda, the nearest point on the mainland of Baja California. The island is 11 miles WSW of the town of Ensenada (Fig. 5).

KEY TO THE SUBSPECIES OF *Lampropeltis zonata*

Excluding snakes from the areas of intergradation, the following key will properly allocate 89 percent of the specimens examined by the author.

A. Posterior margin of first white ring back of angle of mouth ..... B
Posterior margin of first white ring on or anterior to last supralabial ..... D

B. Sixty percent or more of body triads with lateral red areas dorsally confluent, splitting triads C
Less than 60 percent of body triads with red areas dorsally confluent, snout black ..... *multicincta*

C. Snout with red markings, especially on internasals and prefrontals; black of triads greatly restricted laterally ..... *multifasciata*
Snout dark, without red markings; black of triads usually more than one scale wide laterally ..... *zonata*

D. Snout with red markings, especially on internasals and prefrontals ..... E
Snout dark, without red markings ..... F

E. Usually less than 41 body triads ..... *multifasciata*
More than 40 body triads ..... *agalma*

F. No red in pattern ..... *herrerae*
Red in pattern ..... G

G. 36 or fewer body triads ..... *pulchra*
37 or more body triads ..... *parvirubra*

CORRELATION OF VARIATION AND HABITAT

Lampropeltis zonata is found in a number of different plant associations such as chaparral, yellow pine, border-redwood and redwood, but it is not evenly distributed throughout all of these associations. For example, in the south it is found in the chaparral only in montane situations subject to the mollifying influence of the ocean. Again, it apparently does not penetrate the redwood forests north of San Francisco Bay.

There seems to be little correlation between color pattern and habitat. *L. z. pulchra* is found in the chaparral of the Santa Monica Mountains; but farther to the south, in the mountains of San Diego County, the populations here recognized as the same race are restricted to the yellow pine belt. Here the mountains are farther inland, and the habitat is at a higher elevation. Similarly, *L. z. parvirubra* inhabits the chaparral-covered south face of the San Gabriel Mountains and extends up to an elevation of over 6000 feet in the yellow pine belt of that mountain range.

The redwood forests of the Santa Cruz Mountains and the chaparral of the Santa Ynez Mountains are both included within the range of *L. z. multifasciata*.

L. z. multicincta appears to be restricted to the yellow pine belt of the Sierra Nevada, but in Oregon, in the Rogue River Valley area of intergradation with *L. z. zonata*, snakes with the typical pattern of *L. z. multicincta* may be found in areas "where Garry oak, golden oak, madrone, or chaparral are dominant" (Fitch, 1936: 646).

There appears to be little or no correlation between the amount of red and the habitat. Snakes with a high percentage of red are found in the moist redwood areas of the Santa Cruz Mountains, in the chaparral of the Santa Ynez Mountains and in the rather arid yellow pine belt of the Sierra San Pedro Martir. Similarly, snakes with the amount of red greatly reduced occur in the yellow pine belt of the Sierra Nevada, in the pines and chaparral of the San Gabriel Mountains and on tiny South Todos Santos Island off the coast of Baja California.

Nor does the number of body triads correlate with any particular habitat. For example, in one general area in the southern Sierra Nevada, snakes of the race *L. z. multicincta* show a range in number of body triads which nearly equals that for the entire species.

Variation in the position and continuity of the first white ring also shows no correlation with variation in habitat.

Although the range of the species extends through almost nine thousand feet of altitude and through a number of major plant communities, there is no phenotypic evidence of ecotypic differentiation. Probably the ecological distribution, as well as the geographic distribution, is a reflection of individual tolerance and of behavioral adaptation, rather than physiological adaptation of ecological races to a series of narrow sets of environmental conditions. The snakes are exploiting a part of the environment, utilizing from the range of conditions offered by a region only those suited to their needs and rejecting the remainder by retreating below ground or into other shelter.

The basic ringed pattern of *L. zonata* has a disruptive effect when observed in nature. Vivid though the snake appears when removed from its native environment, while it is on the forest floor the broken coloration renders it difficult to discern. However, while the basic pattern would seem to be adaptive, no adaptive significance can be detected in the geographic variation in the pattern.

Interspecific Relationships

Within the *doliata* group of kingsnakes, there are four forms that resemble *L. zonata* sufficiently closely to have received consideration as being close relatives of this species. These are *L. doliata gentilis*, *L. pyromelana*, *L. knoblochi* and *L. ruthveni*.

One of these, *L. ruthveni*, is known only from Michoacán, México, quite remote geographically from *L. zonata*. From a purely geographical standpoint, it seems unlikely that *L. ruthveni* is a direct ancestor of *L. zonata*. More probably the resemblance is fortuitous. When the great range of pattern variation within *L. zonata* is considered, it does not seem remarkable that another member of the *doliata* group should, purely by chance, come to resemble one of the races of *L. zonata*. The problem is to separate such probably fortuitous similarity from resemblance stemming from closer genetic relationship. Geographic considerations should help in this respect.

If it can be assumed that the type ancestral to *L. zonata* originally entered the Pacific Coast region from the east, then a form resembling *L. zonata* and with a range directly to the east of the present range of *L. zonata* may be close to the ancestral type. Both *L. pyromelana* and *L. doliata gentilis* fulfill these requirements.

L. pyromelana resembles *L. zonata* in the body pattern but, particularly in its white snout, has a distinctly different head pattern. It resembles *L. zonata* in having a maximum of 23 dorsal scale rows, but has higher ventral and subcaudal scale counts. Blanchard (1921: 234) found *L. pyromelana* to have a proportionately longer tail and a relatively wider head than *L. zonata*. He also noticed more specialized dentition in *L. pyromelana*. On the basis of these specializations, deviations from the mode of the group as a whole, he considered it unlikely that the more generalized *L. zonata* had descended from the more specialized *L. pyromelana*. *L. knoblochi* of the Sierra Madre Occidental of Mexico is probably conspecific with *L. pyromelana*.

The resemblance of certain individuals of *L. d. gentilis* to *L. zonata*, particularly the race *L. z. multicincta*, is striking. Only a lower ventral scale count and a slight tendency for the white rings to expand at the border of the ventrals serve to distinguish such *L. d. gentilis* from *L. z. multicincta*, at least among preserved specimens. A specimen of *gentilis* from Utah had light rings that were straw yellow dorsally (R. C. Stebbins, field notes), while the rings of *L. zonata* are much whiter, without any yellow color present. It is perhaps significant that the most westerly specimens of *L. d. gentilis*, examined from Colorado, Utah and Arizona, resemble *L. zonata* much more closely than do the *L. d. gentilis* from the plains to the east. No such geographic trend toward *L. zonata* has been noted in *L. pyromelana*.

Blanchard (1921: 227) considered it possible, but unlikely, that *L. d. gentilis* could have been modified to *L. zonata* upon reaching the Pacific Coast region. Smith (1942: 197) grouped *L. zonata* together with *L. ruthveni*, *L. pyromelana* and *L. knoblochi* in an evolutionary line separate from the northern races of *L. doliata*.

The opinion of the author is that *L. zonata* is closely related to, and perhaps even conspecific with, *L. doliata gentilis*. The differences between the two forms are slight and appear even more insignificant when the geographic separation is considered. The ranges of the two forms are now known to be separated by a minimum of 220 miles of rather arid country in the Great Basin and Mojave Desert. Further col-

lecting may narrow both the geographical and morphological gaps.

Speculation on Dispersal and Evolution

Since *L. doliata* exhibits an east–west geographic trend toward *L. zonata*, and *L. d. gentilis* most closely resembles the race of *L. zonata* inhabiting the Sierra Nevada, the Sierran race (*L. z. multicincta*) seems to be a logical candidate for the ancestral position with regard to the other races of *L. zonata*.

It is highly unlikely that the mountain kingsnake has ever dispersed across the great central valley of California, except perhaps at the extreme northern end. The invasion of the coastal and southern California regions from a Sierran foothold might be expected to have taken one or both of two routes: the mountain ranges at the northern or southern ends of the great central valley.

To the north, *L. z. multicincta* and *L. z. zonata* resemble each other in that the first white ring is in the posterior position. This character is given more weight as an indicator of relationships than is given to the more highly variable body pattern characters, and is considered to indicate a close relationship between these forms. The zone of intergradation between *L. z. multicincta* and *L. z. zonata* occupies much of northern California and southwestern Oregon. Whether or not there is a continuous population north into southern Washington (the northernmost verified locality) is not known. The Washington population may have been derived from the Blue Mountains to the east, where mountain kingsnakes are suspected to occur (Johnson, 1939: 2). The more northerly intergradient populations of northern California and southwestern Oregon probably represent a relatively recent northward expansion of the zone of direct intergradation between the two forms, and thus owe their intermediacy not directly to intergradation between *L. z. zonata* and *L. z. multicincta*, but rather to the characteristics of the intergradient population which supplied the dispersants.

The population of the Santa Cruz Mountains (*L. z. multifasciata*) south of San Francisco Bay forms a connecting link between the two extremes of position of the first white ring. All *L. z. multifasciata* from south of this area conform to the anterior position.

To the south, *L. z. parvirubra* was previously considered to be consubspecific with *L. z. multicincta* of the Sierra Nevada (Klauber, 1943: 78). This interpretation finds support in a number of other distributions disjunct between the Sierra Nevada and the mountains of southern California. Examples include *Thamnophis elegans elegans*, *Charina bottae*, *Sceloporus graciosus* and the salamander *Ensatina eschscholtzi* (races *platensis*, *croceater* and *klauberi*). *L. z. parvirubra* was grouped with *L. z. multicincta* on the basis of similar amounts of red on the body; but in the nature of the first white ring, *parvirubra* allies itself with *L. z. multifasciata* rather than with the Sierran type. In view of the great variability observed throughout the species with respect to the amount of red, it is my opinion that the more conservative character, the position of the first white ring, is a truer indicator of relationships.

These observations suggest a pattern of dispersal from a Sierran foothold across the northern end of California and southward along the parallel Sierra Nevada and Coast Ranges. In line with this suggestion, the southern California and northern Baja California snakes may be considered derivatives primarily of the coastal, rather than of the Sierran, complex. It is difficult to picture conditions sufficiently altered to permit migration between the Sierra Nevada and the mountains of southern California that would not permit a far greater volume of exchange with the coastal region to the north.

The invasion of southern California by the north coastal (and Sierran?) prototype must have taken place when conditions were more humid than at present, possibly during a glacial maximum. Following this, increasing aridity restricted the snakes to areas possibly smaller than those now inhabited. The differentiation now evident would have been initiated in all the southern subspecies at about the same time. Each of the different geographic units went its own evolutionary way, proceeding with its own random, seemingly adaptively neutral pattern variation. Alternating arid and humid cycles have allowed some gene exchange between the various populations, but for the most part they have remained separate, a reflection of the remarkable efficiency of even small areas of

unsuited terrain in preventing dispersal of this species.

Genetic drift in small populations is an obvious mechanism suggesting explanation for the apparently randomly fixed variation in the color pattern of the races which inhabit the smallest areas, the races of southern California and Baja California. Adaptive neutrality of the variation has allowed the survival of these widely differing types.

An alternative explanation for the derivation of the pattern of *L. z. herrerae* may be offered. On the basis of area inhabited, hence population size, this race, of all the races of *L. zonata*, could most logically be expected to have acquired its pattern characters by random fixation, inhabiting as it does an island only a little over a mile long. *L. z. herrerae* is phenotypically very similar to *L. getulus californiae* (ringed phase) and occurs in a habitat much more like that of *getulus* than is typical for *zonata* as a whole. It is conceivable that the *getulus* type of pattern is favored by selection in a habitat such as that of *L. z. herrerae* on South Todos Santos Island.

Summary

Lampropeltis zonata is a complex of seven subspecies extending discontinuously between northern Baja California, México, and the southern border of the state of Washington. The variation in pattern is considerable, and seems to show no consistent association with variation in habitat. The closest interspecific relationship appears to be with *L. doliata gentilis* to the east. Dispersal is presumed to have been southward along the parallel Sierra Nevada and Coast Ranges of California. The snakes of southern California and Baja California have closest relationship with those of the California Coast Ranges. Genetic drift in relatively small populations that have become restricted with climatic change may be responsible for the apparently random nature of the variation.

Two new subspecies from southern California are described and five previously named forms are redefined.

Acknowledgments

I am deeply indebted to the following persons for the loan of specimens, for suggestions pertaining to this paper, or for both: Charles M. Bogert, American Museum of Natural History; Dr. Doris M. Cochran, United States National Museum; Dr. Raymond B. Cowles, University of California, Los Angeles; Dr. Wade Fox, University of Southern California; Dr. L. M. Klauber, Zoological Society of San Diego; Dr. Charles H. Lowe, Jr., University of Arizona; Dr. George Myers, Natural History Museum, Stanford University; Kenneth S. Norris, Scripps Institute of Oceanography; C. B. Perkins, Zoological Society of San Diego; T. Reddick, Long Beach Polytechnic High School; J. R. Slevin, California Academy of Sciences; Dr. Hobart M. Smith, University of Illinois; Dr. Robert C. Stebbins, Museum of Vertebrate Zoology, University of California; Dr. Robert M. Storm, Oregon State College; and Mr. William Woodin, III, Tucson, Arizona.

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The Food of the Nightlizards, Genus *Xantusia*

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UNTIL recently, the food habits of the nightlizards of the genus *Xantusia* were almost completely unknown. In 1949, Schwenkmeyer and Knowlton recorded the food of the island nightlizard, *Xantusia riversiana reticulata.* Klauber (1931) recorded the contents of two stomachs of *X. arizonae,* and recently, Miller (1951) made note of the food of *X. vigilis* from Antelope Valley, California. Other isolated food notes, usually based on one or two specimens, may be found in the literature (Heimlich and Heimlich, 1947; VanDenburgh, 1922; Wood, 1944; etc.).

In the present study, 657 stomachs were examined from specimens taken throughout the range of each species. Of the specimens examined, 18 were *X. arizonae,* 252 were *X. henshawi,* 91 were *X. riversiana* (including 67 from San Clemente Island, 20 from San Nicolas Island, and 4 from Santa Barbara Island), and 296 were *X. vigilis.* Unfortunately specimens of *X. gilberti* were not available, but the food of this species is probably much like that of the closely related *X. vigilis.*

The writer wishes to thank Mr. L. M. Klauber for the loan of specimens and records from his collection and that of the San Diego Society of Natural History, and Mr. M. A. Taylor for use of the San Diego State College specimens.

The digestive tract of each lizard was dissected out and the contents were emptied into a dish of water. The percentages of animal, vegetable, mineral, and unidentified organic matter, and of parasites were estimated (Table I). The contents were then examined under the microscope and itemized as to kind (Table II) and number.

The main difficulties met in the study were caused by the small size of the lizards and their nocturnal habits; many of the stomachs contained unidentifiable material, as most of the specimens were caught in the daytime after the previous night's meal had been partly digested.

As a side line to the main study, the nematode parasites found in the digestive tracts of these lizards were noted. These parasites were determined by Dr. A. C. Walton, Knox College, Illinois, as being oxyurids of the genera *Thaparia, Thelandros, Parathelandros* and *Pseudoaleuris.* A few larval and immature filariids were found in *X. henshawi.* The percentage of parasitism by intestinal nematodes in the four species was as follows: *X. riversiana,* 64.8; *X. arizonae,* 22.2; *X. vigilis,* 6.1; and *X. henshawi,* 4.8.

The mineral matter found in the stomachs was present only in small amounts and was probably taken in accidently. The most common minerals found were quartz, mica and feldspar. The grains of sand of these minerals were usually well rounded in stomachs of *X. riversiana* and *X. arizonae,* and sharp in stomachs of *X. henshawi* and *X. vigilis.* The presence of small bits of marine snail shells in stomachs of *X. r. riversiana* from San Nicolas Island sug-

gests occasional foraging about the beach for marine isopods and amphipods.

The unidentifiable organic matter usually consisted of small bits of well-digested material at the lower end of the digestive tract, but occasionally the entire contents of the stomach were so well digested that identification was impossible.

The plant material found usually consisted of leaves, seeds, stems, and bits of other tissue, probably taken in accidently except in the island forms which were obviously omnivorous.

found in only one specimen. The food resembles that found in the closely allied *X. vigilis*.

Ants, beetles and spiders seemed to be the most important foods of *Xantusia henshawi*, although a variety of other insects, centipedes, etc., were also eaten. The type of food eaten can be correlated easily with the habitat of this species which is under granite flakes. The greatest variety of food of this species was found in specimens taken from March to June; only ants and beetles were found in those taken in October and November. This species, with

TABLE I

CONTENTS OF THE DIGESTIVE TRACT OF SPECIES OF *Xantusia*

Number and percentage containing different types of material. S.B. = Santa Barbara Island; S.N. = San Nicolas Island; and S.C. = San Clemente Island.

	arizonae	*henshawi*	*riversiana*				*vigilis*
			S.B.	S.N.	S.C.	Total	
Number examined	18	252	4	20	67	91	296
Number empty	3	64	..	..	9	9	53
Animal:							
Number	12	171	3	20	41	64	152
Percent	80	68.7	75	100	61.1	78.7	51.4
Plant:							
Number	1	5	4	4	36	44	5
Percent	5.6	2	100	20	53.7	57.9	1.7
Mineral:							
Number	3	16	3	13	10	26	20
Percent	16.7	6.4	75	65	14.8	31.6	6.8
Unidentified material							
Number	7	42	4	13	41	64	56
Percent	38.9	16	100	65	70.1	78.4	18.9
Number with 100%	..	12	..	..	9	9	53

X. r. reticulata seemed to be the most nearly vegetarian of the forms studied. Occasionally *Sphagnum* was found in the stomachs, though this was probably eaten while the lizards were confined in jars where it was used for packing.

Most of the animal material comprised insects and other arthropods, though lizard skins (probably their own) were found in *X. henshawi* and *X. riversiana*. Ants (Formicidae) seemed to be the staple diet of the entire genus.

Xantusia arizonae is entirely insectivorous, with ants being found in the greatest number of individuals. Flies (Diptera), beetles (Coleoptera), bugs (Hemiptera), and soft-bodied larvae were the other insects found. Seeds were the widest variety of food, had the lowest incidence of parasitism.

The island species, *Xantusia riversiana*, is, by far, the most pronounced vegetarian of the genus. However the form from San Nicolas Island (*X. r. riversiana*) seems to eat more insects and less plant material than the subspecies (*X. r. reticulata*) from San Clemente Island, which seems to eat more vegetable material than the others, although its diet is rounded out with insects, especially ants. The diet of the lizards from Santa Barbara Island is less completely known due to the lack of material. Beetles and marine isopods were the most important animal foods next to ants; seeds,

TABLE II

SYNOPSIS OF FOOD FOUND IN SPECIES OF *Xantusia*

Numbers indicate number of individuals in which a particular item was found. S.B. = Santa Barbara Island; S.N. = San Nicolas Island; and S.C. = San Clemente Island

Food item	*arizonae* 18	*henshawi* 252	*riversiana*				*vigilis* 296
			S.B. 4	S.N. 20	S.C. 67	Total 91	
VERTEBRATE							
X. vigilis tails	..	..	..	..	..	..	3
Lizard skin: its own	..	4	..	2	15	17	..
INVERTEBRATE							
Arthropods							
Unidentified	..	5	..	..	2	2	7
Spiders: *Total*	..	22	2	4	5	11	5
Unidentified	..	17	2	3	4	9	..
Argiopidae	..	3	..	..	..	..	..
Lycosidae	..	1	..	1	1	2	4
Agelenidae	..	1	..	..	..	..	..
Thomisidae	..	..	..	..	..	..	1
Scorpions	..	1	..	..	2	2	..
Centipedes	..	2	..	2	..	2	..
Ticks: Ixodidae	..	1	..	..	..	..	2
Mites: Thrombidiidae	..	..	..	..	1	1	..
Amphipods	..	..	..	1	..	..	..
Isopods	..	1	..	7	10	17	..
Total Arthropods (other than insects)	..	44	4	18	25	47	19
Insects							
Unidentified	5	72	1	..	25	26	96
Thysanura	..	1	..	..	..	..	..
Orthoptera: *Total*	..	2	..	..	1	1	1
Locustidae	..	2	..	..	..	..	1
Gryllidae	..	..	..	..	1	1	..
Blattaria: Blattidae	..	2	..	..	..	..	..
Odonata: Nymphs	..	2	..	..	..	..	..
Isoptera	..	..	..	..	..	..	5
Homoptera: *Total*	..	3	..	..	1	1	4
Unidentified	..	1	..	..	..	..	..
Aphidae	..	1	..	..	..	..	2
Cicadellidae	..	..	..	..	1	1	2
Membracidae	..	1	..	..	..	..	..
Hemiptera: *Total*	2	10	1	1	1	3	21
Unidentified	2	5	1	1	1	3	8
Miridae	..	1	..	..	..	..	..
Pyrrhocoridae	..	..	..	..	..	..	3
Lygaeidae	..	3	..	..	..	..	2
Coreidae	..	1	..	..	..	..	8
Lepidoptera: *Total*	..	8	..	2	3	5	11
Larvae	..	7	..	2	3	5	10
Noctuidae: Adult	..	1	..	..	..	..	1
Diptera: *Total*	4	13	..	1	2	3	14
Unidentified	1	5	..	..	1	1	4
Culicidae	..	..	..	1	..	..	..
Chironomidae	1	..	..	..	..	..	..
Dolichopodidae	..	..	..	..	..	..	1
Schizophora	1	..	..	..	..	..	1
Conopidae	..	..	..	..	..	..	1

TABLE II—*Continued*

Food item	*arizonae* 18	*henshawi* 252	*riversiana*				*vigilis* 291
			S.B. 4	S.N. 20	S.C. 67	Total 91	
Protomuscaria	..	..	..	..	..	..	6
Chloropidae, egg	1	..	..	..	..	..	..
Muscoidea	..	..	..	..	1	1	..
Sarcophagidae	..	1	..	..	..	..	1
Phoridae	..	4	..	..	..	..	..
Larvae or pupae	..	3	..	..	..	..	..
Coleoptera: *Total*	2	54	1	9	9	19	49
Unidentified	..	15	1	2	6	9	13
Carabidae	..	16	..	4	..	4	11
Staphylinidae	..	..	..	2	..	2	1
Elateridae	..	..	..	..	..	..	1
Buprestidae	..	1	..	..	..	..	..
Coccinellidae	..	..	..	..	..	..	1
Tenebrionidae	1	14	..	1	1	2	15
Scarabaeidae	..	4	..	..	..	..	..
Chrysomelidae	1	2	..	..	1	1	1
Curculionidae	..	2	..	..	..	..	..
Larvae	..	..	..	..	1	1	6
Hymenoptera: *Total*	7	79	1	8	16	25	90
Unidentified	..	2	..	..	..	..	1
Formicidae	6	75	1	5	16	22	83
Ichneumonoidea	..	..	..	..	..	..	1
Chalcidoidea	1	..	..	..	..	..	2
Eurytomidae	..	..	..	..	..	..	1
Tetrastichidae	..	..	..	..	..	..	1
Apoidea	..	..	..	..	..	..	1
Anthophoridae	..	..	..	3	..	3	..
Apidae	..	2	..	..	..	..	..
Unidentified larvae	2	..	..	..	..	..	4
Insect Eggs	..	1	..	..	..	..	3
PLANTS: *Total*	1	5	4	20	36	44	5
Seeds	1	1	2	2	15	19	1
Stems	..	1	1	1	23	25	1
Leaves	..	1	..	2	10	12	..
Mesembryanthemum	..	..	..	..	3	3	..
Flowers	..	..	..	..	11	11	..
Unidentified tissues	..	1	..	1	12	13	1
Sphagnum (packing)	..	2	3	..	1	4	2

stems, and leaves were the major plant foods. *Mesembryanthemum*, noted by Schwenkmeyer (1949), was found only in the San Clemente specimens; also, flowers were found only in the subspecies from this island.

Insects constitute the greater portion of the food of *Xantusia vigilis*. Ants are the most important, but beetles, bugs and flies are also found in large numbers. Miller (1951) found termites important in the food of this species. In the present study, termites were found in the stomachs of five specimens, three of which were from the area of Miller's study, though many more were examined from that region. This species seems to have a greater variety of insects in its diet, including many families of some economic importance. Ticks (*Dermacenter*) were found in two specimens of *X. vigilis*. Heimlich and Heimlich (1947) recorded the presence of *X. vigilis* tails in the stomachs of individuals of the same species which had been kept in captivity. Three additional cases of cannibalism two from

the same locality, were found in this study, but it is not known if these records are from captive animals. The greatest variety of food was found in specimens collected in March, April, May and June; those taken in October and January had eaten only ants, beetles and bugs.

The food of the as yet undescribed subspecies of *X. vigilis* from north central Baja California appears to be no different from that of the species as a whole. It is therefore suggested that the food of the closely related *X. gilberti* from the Cape of Baja California (and of which no specimens were available) is similar to that of *X. vigilis*.

Summary

The digestive tracts of 657 specimens of *Xantusia* were examined. It was found that *X. riversiana* eats the widest variety of foods, including a great deal of plant matter; this is especially true of *X. r. reticulata* from San Clemente Island. *X. henshawi* eats many insects as well as other arthropods, especially spiders. *X. vigilis* is primarily insectivorous, but occasionally eats other arthropods. *X. arizonae* is the most restricted in its diet, eating only insects. Ants seem to be the major food of the genus, with beetles next in importance. The degree of parasitism by intestinal nematodes is highest in the plant-eating *X. riversiana* and lowest in *X. henshawi*.

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The Mouth Parts of Tadpoles of the Spadefoot Toad, *Scaphiopus hammondi*

Frederick B. Turner

Within the genus *Scaphiopus* the larvae of the *hammondi* complex average larger than those of the other species. They attain a length of about 65 mm. and transform at sizes between 13 and 24 mm., whereas tadpoles of the others range from about 21 to 28 mm. in maximum length and transform at sizes between 7.5 and 12.5 mm. (Wright and Wright, 1949). The same authors (*op. cit.*) consider *Scaphiopus hammondi* to be composed of three subspecies: *hammondi, bombifrons* and *intermontanus*.

It has been considered possible to distinguish the tadpoles of *S. h. hammondi* from *S. h. bombifrons* and *S. h. intermontanus* on the basis of mouth structures, the former presumably possessing a beak on the upper mandible and a notched lower mandible, the other two races lacking such configurations (Bragg, 1941; Wright and Wright, 1949).

This paper presents the results of an investigation of the three subspecies of *Scaphiopus hammondi*, with special emphasis on the mouth structures in an attempt to determine the validity of the above-mentioned criteria, and, incidentally, to gain some conception of the amount of variation within populations and between populations from different localities.

Recent work has shown that *Scaphiopus hammondi bombifrons* extends westward across central New Mexico into Mexico and possibly into Arizona, overlapping the range of *S. h. hammondi* considerably. That this sympatric association is not reflected by the nomenclature

used by Wright and Wright (1949) is immediately evident, and some workers choose to consider *bombifrons* a distinct species. Since the present study is not an attempt to settle the taxonomic status of this complex, Wright's nomenclature has been adopted.

Scaphiopus hammondi hammondi

Fry, Cochise County, Arizona; July 21, 1949; 78 specimens, MVZ 49065. (Since this locality may lie within an area inhabited by both *S. h. hammondi* and *S. h. bombifrons*, the sample cannot be assigned with certainty.) These comprised the most uniform sample observed. The upper mandible was not beaked and the lower mandible was not notched. (Fig. 1, a.)

Rice Creek, 6 miles south of Corning, Tehama County, California; May 20, 1937; 61 specimens, MVZ 24121. There was considerable variation within this sample. Four individuals exhibited a strongly beaked upper mandible and a notched lower mandible. (Fig. 1, b.) Five possessed beaks with the lower mandible weakly notched (like Fig. 1, b). Three lacked beaks but the lower mandible was notched (like Fig. 1, f), and in 14 there was a suggestion of a beak with the lower mandible smooth (like Fig. 1, c). However, the majority of this sample, 35 specimens, possessed upper mandibles with no suggestion of a beak and lower mandibles without a notch (or at most only slightly sinuate).

Two miles west of Sierra Madre, Los Angeles County, California; May 20, 1913; 25 specimens, MVZ 4867. Again considerable variation was encountered. Five individuals had the upper jaw slightly beaked, the lower mandible, slightly notched. Five exhibited a similar upper jaw, and the lower rounded or, at most, a very obtuse angle (Fig. 1, d). Three possessed a sinuate upper jaw with the lower slightly notched. Again the majority, 15, exhibited neither beak nor notch, or at most a somewhat sinuate upper jaw.

Three miles east of Whitmore Tub, Long Valley, Mono County, California; July 12, 1922; 49 specimens, MVZ 8642. (Possible area of intergradation between *S. h. hammondi* and *S. h. intermontanus*). This sample afforded an opportunity to determine if age is responsible for variations in structure of mouth parts. Twenty-eight young specimens, ranging in size from 27 to 51 mm., showed relatively great uniformity. Both mandibles lacked any irregularities in 26 individuals, and the other two exhibited rather prominent beaks but the lower mandibles lacked a notch. Twenty-one older specimens, ranging in size from 65 to 70 mm., showed a similar uniformity. Nineteen lacked both beak and notch and two showed only a slightly sinuate upper mandible.

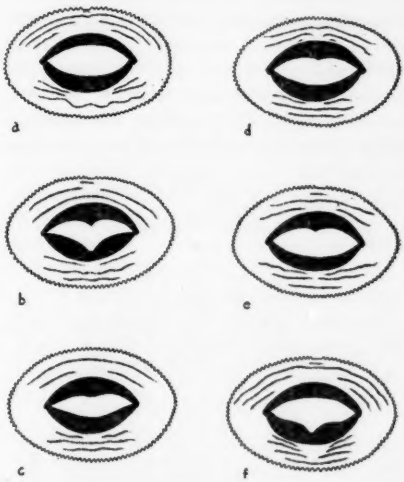

Fig. 1. Nature of mouth structures including the mandibles, the labial teeth rows and the papillary fringe: a, *Scaphiopus hammondi hammondi*, Fry, Cochise County, Arizona; b, *Scaphiopus hammondi hammondi*, six miles south of Corning, Tehama County, California; c, *Scaphiopus hammondi hammondi*, two miles southwest of Sierra Madre, Los Angeles County, California; d, *Scaphiopus hammondi hammondi*, two miles southwest of Sierra Madre, Los Angeles County, California; e, *Scaphiopus hammondi bombifrons*, four to five miles southwest of Erick, Beckham County, Oklahoma; and f, *Scaphiopus hammondi intermontanus*, Sink Valley, Kane County, Utah.

Scaphiopus hammondi bombifrons

Four to five miles southwest of Erick, Beckham County, Oklahoma; June 12, 1946; 9 specimens, MVZ 47169. Two individuals exhibited both a beak and a notched lower mandible while four showed neither of these characteristics. Three possessed a beak but the lower mandible lacked a notch. (Fig. 1, e.)

Two miles northeast of Lawrence, Douglas County, Kansas; June 5, 1950; 42 specimens, RCS 4676. Thirty-one of these had neither

beak nor notch. Eleven showed some suggestion of a beak on the upper mandible, with the lower lacking a notch. The upper mandible in a few from the former group had from 4 to 5 slightly elongate medial serrations, but these by no means composed a beak.

Scaphiopus hammondi intermontanus

Sink Valley, Kane County, Utah; June 30, 1949; 17 specimens, MVZ 49056. (Possible area of intergradation between *S. h. intermontanus* and *S. h. hammondi.*) None of these had a beak or even a suggestion thereof, but 12 had a very prominent notch in the lower jaw. (Fig. 1, f.) The remaining five lacked a notch, possessing only a V-shaped mandible.

TABLE I
SUMMARY OF OBSERVATIONS ON MOUTH PARTS OF *Scaphiopus hammondi*

Subspecies	Upper mandible with beak; lower mandible notched or slightly so	Upper mandible with beak; lower mandible without notch	Upper mandible without beak or at most sinuate; lower mandible notched or slightly so	Upper mandible without beak; lower mandible without notch or at most a V of varying acuteness	Upper mandible slightly beaked to sinuate; lower mandible without notch	Totals
hammondi	14	7	6	173	16	216
bombifrons	2	3	0	35	11	51
intermontanus	0	0	12	45	0	57
Totals.....	16	10	18	253	27	324

Deep Springs Valley, Inyo County, California; June 20, 1949; 35 specimens, MVZ 49045. (Possible area of intergradation between *S. h. intermontanus* and *S. h. hammondi.*) These were quite uniform. The upper mandible was quite regular and the lower lacked a notch, varying from an elliptical arc to a shallow angle.

Quinn River Crossing, Humboldt County, Nevada; May 24, 1909; 5 specimens, MVZ 1577. The surface of the edge of the mandible in each of the five specimens was quite regular, possessing neither notch nor beak.

DISCUSSION

On the basis of the above data the various subspecies are not separable on the character of the mouth structures (Table I). Both *S. h. hammondi* and *S. h. bombifrons* may have a distinct beak on the upper mandible and all three subspecies may have a prominent notch in the lower. Indeed, in certain samples, the variation within one population may be of the same magnitude as that which has been formerly supposed to differentiate subspecies. On the whole, the presence of a beak on the upper mandible seems to be a relatively uncommon characteristic. That it might be regularly present in a certain population or even within all populations in some areas is possible, however, and this may be the basis for the statements that it is a diagnostic character in *Scaphiopus h. hammondi.*

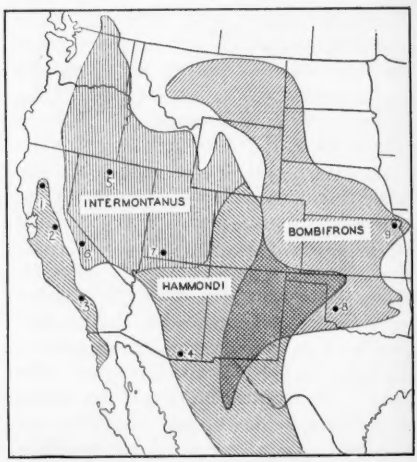

Fig. 2. Distribution of the subspecies of *Scaphiopus hammondi* (after Wright and Wright, 1949, and Stebbins, 1951), with locality records of samples used in the present study.
1. Six miles south of Corning, Tehama County, California.
2. Three miles east of Whitmore Tub, Long Valley, Mono County, California.
3. Two miles southwest of Sierra Madre, Los Angeles County, California.
4. Fry, Cochise County, Arizona.
5. Quinn River Crossing, Humboldt County, Nevada.
6. Deep Springs Valley, Inyo County, California.
7. Sink Valley, Kane County, Utah.
8. Four to five miles southwest of Erick, Beckham County, Oklahoma.
9. Two miles northeast of Lawrence, Douglas County, Kansas.

There is the possibility of approaching the problem from the aspect of the distribution of

the sampled populations in relation to the distribution of the subspecies as a whole. That is, if the sampled populations are from areas of intergradation, considerable variation might well obtain. On this basis one might expect from the distribution pattern (Fig. 2) that extreme variation would occur within the samples from Mono and Inyo counties, California, and Kane County, Utah, since these are areas where intergradation between *S. h. hammondi* and *S. h. intermontanus* could occur. Conversely, one might expect the other populations, well within the established ranges of their respective races, to be relatively uniform. However, the former are relatively uniform while those exhibiting the most variation are from Tehama and Los Angeles counties, California, localities well within the range of *S. h. hammondi*. The Nevada, Arizona and Kansas samples show the relatively great degree of uniformity that might be expected. The suspicion that considerable variation exists in these larvae, not only in the nature of the mouth structures but also in other characteristics, has been voiced before (Brues, 1932: 281–83).

Apparently the nature of the mouth structures is independent of age except with respect to changes near the time of transformation. These changes, just prior to metamorphosis, involve the disappearance of the labial teeth rows and the horny mandibles and the replacement of the latter by the typical adult mouth structure.

Some difficulties were encountered in making the above observations. The mandibles of the larvae are rather flexible and great care must be taken in order that their normal configuration is not distorted by the instruments used in examination.

During the observations some incidental notes were made on other characteristics of presumed taxonomic significance. The labial teeth rows varied from 2/3 through 2/4 and 3/3 to 3/4, within the limits given by Wright and Wright (1949). The characteristic papillary fringe, continuous except for a very short mid-dorsal gap, was typical of almost all specimens observed. The most notable exception was the sample from near Sierra Madre, Los Angeles County, California, in which the majority of the specimens lacked the small gap entirely.

I conclude on the basis of the above observations that (1) the configuration of the mandibles in *Scaphiopus hammondi*, as a taxonomic criterion, is of no value; and (2) apparently there is no significant modification of the shape of the mouth parts with age except those changes related to transformation.

The writer wishes to acknowledge criticisms and suggestions by Dr. Robert C. Stebbins of the University of California Museum of Vertebrate Zoology.

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A New Toad from the Highlands of Guatemala and Chiapas

Philip W. Smith

In a small collection of amphibians and reptiles secured in southern Chiapas by C. J. and M. Goodnight and L. J. Stannard in August, 1950, were four juvenile toads tentatively regarded when received as immature *Bufo valliceps* Wiegmann. A reexamination of these toads has revealed that they are quite unrelated to *valliceps* and are of an apparently undescribed species.

Four additional specimens of the same toad,

called to my attention by Drs. L. C. Stuart and Norman Hartweg, were made available through the courtesy of Norman Hartweg, Joseph R. Slevin, and Clifford H. Pope. I am indebted to each for the loan of material, to Dr. E. H. Taylor for much needed advice in this study, and to W. L. Burger for permission to use his South American literature index. Drs. Stuart and Hartweg, both of whom had prior interest in the problem but nevertheless generously turned over to me their material, have my sincere thanks. Dr. Stuart's contribution includes indication of the exact specimens to be borrowed for study. Dr. Hobart M. Smith with characteristic patience has offered suggestions and encouragement on numerous occasions.

Bufo tacanensis, sp. nov.

Plate I

HOLOTYPE.—Univ. Mich. Mus. Zool. 88359, adult female, collected at 1500 meters on Volcán de Tacaná, Unión Juárez, Chiapas, México, by Pierce Brodkorb, March 18, 1938.

PARATYPES.—Univ. Mich. Mus. Zool. 102472 from Quetzaltenango, Granaja Lorena, Guatemala, by L. C. Stuart, April 21, 1949 (1700 meters); Calif. Acad. Sci. 70691, Volcan Zunil, Guatemala, by J. R. Slevin, Aug. 8, 1924; Chicago Nat. Hist. Mus. 35063, Río Samala, Finca Montecristo, Guatemala, January 31, 1940; Ill. Nat. Hist. Surv. 6177–8 and Univ. Ill. Mus. Nat. Hist. 24873–4, Volcán de Tacaná above Cacahuatán, Chiapas, México, by C. J. and M. Goodnight, August, 1950.

DIAGNOSIS.—A medium sized *Bufo* with depressed head, well developed interorbital, parietal, and postorbital crests; smooth crown; sharply angled canthus; minute ostia pharyngea; parotoid 1½ times as long as wide and contacting posterior edge of eyelid; almost fully webbed feet; and lacking a tympanum.

DESCRIPTION OF TYPE.—Head from above flattened, width (19.5 mm.) greater than length (14.5 mm.) and depth (8.2 mm.); nostrils sub-terminal, nearer eyes than to each other; greatest length of eyelid, 7 mm.; greatest width, 4.6 mm.; interorbital crests arising near anterior border of eye, reaching greatest height just before juncture with parietals; skin between crests and on snout fused with bone and smooth; interorbital space greater than width of eyelid, widest at junction of interorbital and parietal crests; postorbital and interorbital crests forming obtuse angle, almost a curve; postorbital crests short, coalescing with anterior edge of parotoid gland; parietal crests distinct, curving posteromedially; eyelids and parotoids tubercular; parotoids large and widely separated, almost twice as long as wide, touching posterior edge of eyelids; head from lateral view flattened; sides of snout vertical; postocular and subparotoid regions covered with tubercular skin; tympanum invisible; eye succeeded by two vertical, gland-like spiny ridges.

Choanae large (1 mm.), diameter of one approximately ¼ the interchoanal space; tongue long and narrow, length more than twice the greatest width, posterior third free; ostia pharyngea minute; vocal slits absent.

Dorsum with numerous small tubercles, increasing in size laterally and posteriorly; forelegs and femora with many closely set spines, reaching greatest size on rear of thighs; sides with large spine-tipped tubercles in more or less linear series from posterior edge of parotoids to groin; venter and undersurfaces of limbs sandpaper-like; fingers long and slender, first and second subequal; one large and one very small inner palmar tubercle; short rudimentary tarsal fold; two small palmar pustules on hind feet, lower pustule twice size of upper; subdigital tubercles simple and pustular; ultimate three joints of the 4th toe extending beyond web, other toes almost fully webbed.

Back and top of head yellow-brown, somewhat darker middorsally; sides of head and outer fourth of parotoid glands darker brown, continuous with a dark lateral stripe; chin and belly light; breast region and under sides of legs mottled with black; upper surfaces of hindlegs dark with scattered irregular patches of dirty yellow.

Snout–vent length, 53 mm.; snout to eye, 6.2 mm.; head width at angle of jaws, 19.5 mm.; length from angle of jaws to tip of snout, 14.5 mm.; head depth, 8.2 mm.; femur, 21.5 mm.; tibia, 23 mm.; foot, 36 mm.

VARIATION.—The seven paratypes are separable into four distinct size groups and exhibit ontogenetic variation in several features. The venter of juveniles is predominantly black with scattered light spots; in adults the venter is light with dark mottling on the breast and

Univ. Mich. Mus. Zool. 88359, holotype of *Bufo tacanensis*, new species.

scattered dark spots on the belly. The cranial crests are barely discernible on specimens less than 20 mm. in snout–vent length but distinct on specimens of 30 mm. The crown of the head is tubercular in specimens less than 20 mm. from snout to vent, smooth in larger specimens. The legs are proportionately longer in juveniles (tibia 47–53 percent the snout–vent length in five immature toads, 42–44 percent in three adults). The lateral dark stripe is more prominent in small specimens. Two specimens less than 20 mm. from snout to vent possess a dark inverted V mark between the shoulders and another at midback; larger specimens are unmarked dorsally. Snout and canthus of juveniles are more sharply angled and the head is distinctly flat topped. The interdigital web of immature toads is more deeply incised, making the feet appear only three fourths webbed.

Variation other than in those features correlated with size is less marked. The tongue is shorter and thicker in the paratypes and the ground color varies from yellow-brown with dark brown lateral bands to dark gray with black lateral stripes.

Remarks.—The relationships of *Bufo tacanensis* are at present uncertain and must await an understanding of the natural groups within the genus. If the absence of auditory equipment is a phylogenetically conservative character, *B. tacanensis* may be allied to species of the non-recognized genus *Cranophryne* Cope (*simus*, *bocourti*, *fastidiosa*) with which the new species agrees in the absence of tympani and its apparently restricted distribution but differs by the possession of ostia pharyngea. The extreme diversity of species of *Cranophryne* and the intermediate position of *B. tacanensis*, however, make *Cranophryne* a questionable natural group. Moreover, instability of the auditory character is suggested by occurrence in several other parts of the world of species with a degenerate auditory apparatus. Nevertheless the mere existence of so many species in Central America with extraordinary otic reduction, whereas elsewhere such reduction is unusual, poses a serious problem if polyphyly is admitted.

Bufo veraguensis (Schmidt, 1857) was diagnosed as having the openings of the eustachian tubes "small and hidden." This and such other characters as the invisible tympanum, slender toes, and extent of webbing suggest *B. tacanensis*. Schmidt's figure (pl. II, fig. 20) of the head of *veraguensis* shows the parotoid glands to be well separated from the eyelids by supratympanic crests, thus eliminating *veraguensis* from consideration.

Of the known Mexican species, *B. occidentalis* Camerano most closely resembles *B. tacanensis*, sharing the presence of pharyngeal ostia, a similar position of parotoid glands, similar habitus, and invisibility (in some *occidentalis*) of the tympani. The reduction of an external tympanum occurs in presumably unrelated species, and its occurrence in *B. occidentalis* varies individually. Removal of the tubercular skin behind the eye of *occidentalis* reveals a well developed tympanum. Dissection of a paratypic *B. tacanensis*, however, revealed no trace of the organ. In addition, *B. occidentalis* has a shorter, less truncate snout; the body is less depressed and variously mottled but not longitudinally banded; the venter of juveniles is light; the cranial crests are less prominent; and the webbing of the toes is much less extensive.

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Illinois Natural History Survey, Urbana, Illinois.

Climatic Factors Influencing the Breeding Migration of the Spotted Salamander, *Ambystoma maculatum* (Shaw)

RICHARD J. BALDAUF

VARIOUS factors affecting the breeding activities of amphibians, particularly of ambystomid salamanders, have received much attention during the past 50 years. The present study was made to determine the climatic factors influencing the appearance of *Ambystoma maculatum* in breeding ponds near Reading, Berks County, Pennsylvania. It has become impossible to continue the observations, but the results of the study, although incomplete, are herewith made available.

Thanks are extended to Messrs. Elwood Manning, Paul Jensen, Edward Hill and Samuel C. Gundy for providing data from their personal notes, and to the U. S. Department of Commerce, Weather Bureau, Reading, Pennsylvania, for fulfilling requests for climatological data. Sincere gratitude is due my wife and Mr. and Mrs. Lawrence Dillon who accompanied me on many night excursions and helped in many ways.

HISTORICAL SUMMARY

Wright and Allen (1909: 688) were the first to point out in any detail the factors influencing the spring migration of the spotted salamander. They concluded that "it is obvious that a temperature approximately 50°F. or more almost invariably caused the species to emerge [from hibernation]." This conclusion was based on seasonal temperature readings of the air from 1903 to 1908, inclusive. Smith (1911: 17) said that "It seems quite probable that, in the case of *A. tigrinum* at least, migration is an event depending somewhat upon ecological conditions."

The first careful attempt to correlate the spring activities with climatological factors was that of Blanchard (1930). In his summary he writes (pp. 165–167): "The factors presented seem to show that migration to the breeding ponds depends, in this species [*A. maculatum*], on rain and not on temperature. A winter rain coming before any thawing of the surface of the ground or while the ground is covered with snow will, of course, have no effect on the salamanders . . . we may say then that in such climate as that of southern Michigan the spotted salamanders begin migration to the breeding ponds during the first rain at night following the disappearance of snow and thawing of the surface of the ground in woods. . . ."

However, the data in Blanchard's scholarly report were not fully interpreted. Wright, in a footnote to Blanchard's paper (p. 167), emphasized "the great importance of rain, moisture and humidity as factors in the breeding of amphibians." Also, "Temperature, as a factor, is usually secondary, but on occasions may be of much importance. I regard the most necessary conditions for each species as humidity above a more or less specific minimum temperature."

Bishop (1941: 113–114) added to the conclusions of Blanchard: "I would qualify this theory by adding that, in eastern New York, migration of this species and *A. jeffersonianum* may be initiated by rains during the day and even by the rapid run-off of snow water following a pronounced rise in temperature."

METHODS

In 1947, observations were begun on four ponds located in a hollow, between a stream and a bank, within 500 yards of the rear entrance of the Carsonia Amusement Park, Berks County, Pennsylvania. The ponds are in a more or less northeast-southwest linear arrangement, draining one into the other during heavy rains. One pond was more or less permanent, but the others persisted only during the early spring thaws and rains. Two of the temporary ponds occupied a grassy area and were rarely more than 12 inches deep; the other was partially surrounded by a concrete abutment.

Attempts were made to start nightly observations before the spring rains began, in order to witness the first appearance of the salamanders. Often, when observations could not be made at night, the ponds were examined and a search for salamanders was made the following day. Temperature readings, in degrees Fahrenheit, of water and air were made,

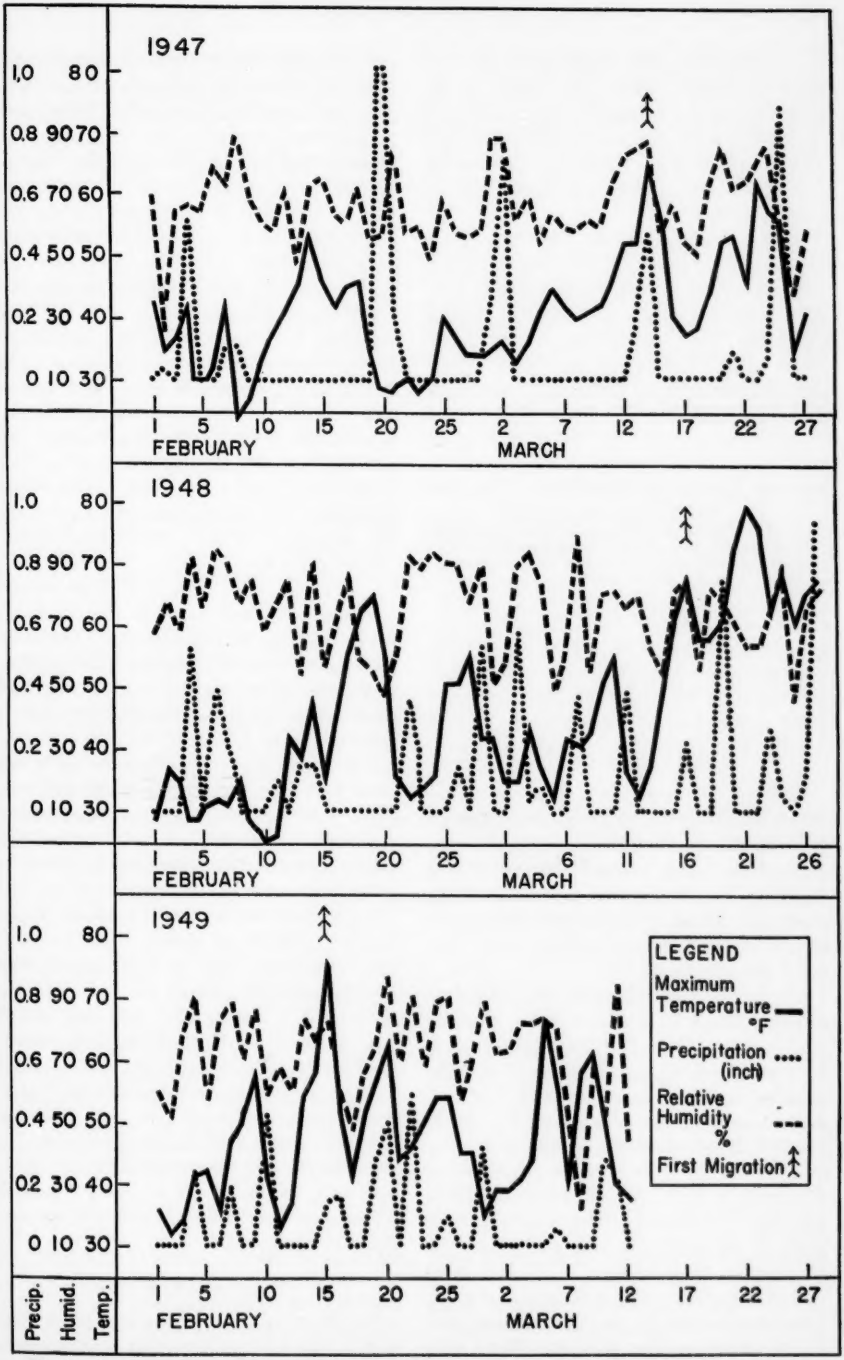

Fig. 1. Maximum temperature, precipitation, relative humidity, and the first migration of *Ambystoma maculatum*, in 1947, 1948 and 1949.

but not regularly. Freezing temperatures were often encountered during the course of the study. It was not unusual to observe the salamanders on a comparatively warm, rainy night only to find them the following night beneath a sheet of ice. Eggs were seen frozen in the ice more than once.

Since not all salamanders hibernate at the same distance from the breeding ponds, it follows that not all individuals make the complete migration on the first night of suitable conditions. Thus, other things being equal, those salamanders appearing first were probably hibernating closer to the ponds than those appearing later.

TABLE I

WEATHER DATA ON THE FIRST DAY OF MIGRATION IN 1947, 1948 AND 1949

Time of migration = MT; temperature range during time of migration = TR-MT; temperature range for whole 24-hour period = TR-WP; relative humidity = RH; precipitation = P (in inches)

Date	MT	TR-MT	TR-WP	RH	P
1947: March 14	3–6 AM	55°–56°	41°–64°	87	0.47
1948: March 16	1–6 AM	56°–60°	56°–68°	86	0.23
1949: Feb. 15	6–9 PM	58°–62°	50°–76°	83	0.14

OBSERVATIONS IN 1947

Eighteen visits were made to the ponds between March 13 and April 4. On March 13 (8–9 PM) the water temperature varied between 39° and 41°; snow covered the ground and there was no evidence of *A. maculatum* in the ponds. On March 16 (afternoon) many spermatophores were observed and two adults were found beneath an old log.

The initial migration must have occurred on either March 14 or 15. On the basis of the records it is unlikely that the migration took place on March 15, since the rain (0.01 inch) of that date fell between 7 and 8 PM. Further, the average temperature between 7 PM, March 15 and 7 AM, March 16 was rather low, ranging from 29° to 39°. The weather conditions of March 14, however, presented a different picture (Fig. 1; Table I). The maximum temperature on that date was 64.0°, and the temperature range between 3 AM and dawn was 55.0° to 56.0°; also, 0.47 inch of rain fell between 3 AM and 11 AM. These factors plus an 87 percent relative humidity offered suitable conditions for the initial migration.

Apparently, not all of the salamander population was activated on March 14, and probably only those hibernating close to the ponds reached them that night. The remainder, presumably, had to make the migratory trip by degrees, as conditions permitted. The observations and climatic data indicated that the late arrivals did not reach the ponds *en masse* on any particular date. They probably wandered closer and closer, night by night, eventually reaching the ponds and thus gradually increasing the number of breeding individuals. Newly deposited spermatophores were found as late as March 24 and freshly laid eggs as late as March 31. The date of the last arrivals is, of course, unknown; but it is virtually certain that breeding activity was over by April 3, for neither salamanders, fresh eggs nor spermatophores were present on that day or the day following.

OBSERVATIONS IN 1948

Eleven visits were made to the ponds between February 26 and March 27. The three observations made in February gave negative results. On March 15, there were no signs of salamanders, but on the afternoon of the 16th a male and a female were seen and spermatophores were abundant in both the upper and lower ponds. On the evening of the 16th, between 8:30 and 9:00 PM, adult salamanders were found to be abundant in all ponds. They were very active and were concentrated in groups in the areas containing spermatophores.

During the 12-hour period between 10 PM, March 15, and 10 AM, March 16 the temperature ranged from 56.0° to 62.0°, the relative humidity from 81 (March 15) to 86 (March 16) percent, and there was a 0.24-inch rainfall (Fig. 1; Table I). Thus, during that period, temperature, relative humidity, and rainfall were all, apparently, favorable to the initiation of migration for the year 1948. A second migration occurred the night of March 19; three hours after the termination of a 0.75-inch rain, on March 20 at 2:00 AM, adult salamanders were abundant and new spermatophores were found.

OBSERVATIONS IN 1949

On the afternoon of February 16, Samuel Gundy saw adult salamanders in the ponds. On February 20, spermatophores were found

in all three ponds. Egg complements were not observed until the afternoon of February 27. As late as March 23, newly deposited spermatophores and eggs were found.

On February 15, 1949, suitable conditions obtained to initiate migration. The maximum temperature was 76.0°, the minimum, 50.0°; the relative humidity was 83 percent and there was a 0.14-inch rainfall between 4:00 and 9:00 PM, the period during which the first migration probably started (Fig. 1; Table I). Although the conditions were suitable for migration on this date, they persisted only long enough to allow the few individuals, observed on February 16, to reach the breeding ponds. The larger migration took place after March 5. The finding of new egg masses, spermatophores and 18 adults on March 23 indicated that the main migration occurred between March 5 and March 23. Unfortunately it was found necessary to abandon observations during that interval.

Summary

In general, the observations in Berks County, Pennsylvania, are in accord with those made by previous workers in other localities. Wright and Allen (1909) stated that an air temperature of 50° or more caused the species to emerge from hibernation, whereas the present study indicates a slightly higher minimum (55°). Although Blanchard (1930) stated that migration is dependent upon rain, his data do not disprove that temperatures well above 32° may be important correlatives. Besides, Bishop's observation (1941), that migration may be stimulated by the rapid run-off of snow water following a pronounced rise in temperature, shows that the requisite moisture may be provided by means other than rainfall.

The present study seems to indicate that humidity and temperature were the most important factors in the spring migration of the spotted salamander during the 3-season period. And, in the light of this and the previous studies already mentioned, it appears that, given the proper temperature, the necessary moisture may be supplied by rainfall, snow water runoff, or water vapor in the air.

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Herpetological Notes

A CONCENTRATION OF JUVENILE SPOTTED SALAMANDERS, *AMBYSTOMA MACULATUM* (SHAW).—While making herpetological collections at Camp Boy Haven, Calvert County, Maryland, observations were made on a concentration of recently metamorphosed *Ambystoma maculatum*.

Camp Boy Haven is located on the Coastal Plain at the top of a rather steep, heavily forested hill overlooking Chesapeake Bay. Between the hill and the sandy beach there is a shallow fresh-water, swamp-marsh habitat from which the specimens observed may have originated. Breeding activities were observed in this pond during March, 1950, and numerous adults have been collected in the area during the spring months.

On July 31, 1950, collecting activities throughout the day yielded only two spotted salamanders. These were taken from beneath peices of driftwood on the sandy beach (an unusual habitat for this species) not more than 20 feet from the edge of the bay. The afternoon was extremely warm and during the evening a heavy rain storm occurred which lasted until about 10 o'clock. The temperature was lowered considerably and hylas which had been calling on previous nights were not heard.

Shortly after dark, during a lull in the storm, J. D. Hardy, Sr., observed literally hundreds of

recently transformed spotted salamanders on a dirt road which runs through Camp Boy Haven. They seemed to be leaving the adjacent woods and congregating along the center of the muddy road. Mr. Hardy collected 20 individuals at that time. Shortly after midnight, however, a search was made for other specimens, but none could be found. Likewise, none was located the following day.

Edgren (1949, Herpetologica, 5(6): 137–38) described a concentration of *Ambystoma jeffersonianum*. He suggested that recently transformed salamanders are "highly vulnerable to changes in environmental factors after having been adjusted to the relatively stable conditions extant in the parental pond."

Bishop (1943, Handbook of salamanders) stated that transformation of *Ambystoma maculatum* occurs from August to October. The Boy Haven salamanders, then, transformed rather early and may have been seeking terrestrial niches for the first time, or they may have been forced from such niches by sudden environmental changes; on the other hand, the heavy downpour may have provided a temporary environment ideal for a migrational spurt.

The migration of adult spotted salamanders is a commonly observed phenomenon in Maryland, but despite extensive collecting in the Camp Boy Haven area during each July and August from 1946 to 1950, no similar concentrations of recently transformed individuals have been noted. Young ones have been taken rarely in or beneath logs and debris in the forest surrounding the camp area and about 2 miles south, at Cove Point.

The 20 salamanders taken from the Boy Haven concentration average 50 mm. in length; all show traces of gill slits, and the dorsal spots are small and poorly developed. The specimens are deposited in the collections of the Natural History Society of Maryland.

A word of appreciation is due Richard A. Edgren, of Northwestern University, Evanston, Illinois, and Romeo Mansueti, of the Department of Research and Education, Solomons, Maryland, for their assistance in the preparation of this paper.—JERRY D. HARDY, JR., *Natural History Society of Maryland, Baltimore 17, Maryland.*

THE CORRECT GENERIC NAMES FOR THE IGUANID LIZARDS OF MADAGASCAR AND THE FIJI ISLANDS.—While engaged in studies preliminary to a projected revision of the lizard family Iguanidae, it was necessary to consider the proper generic names for the single South Pacific and two Madagascar genera of the family. The following brief notes are presented in the hope that they will correct certain fundamental errors generally accepted in recent herpetological literature on these genera.

The monotypic genus *Brachylophus* Cuvier, 1829 (monotype, *Iguana fasciata* Brongniart, 1780) is found on the Tonga and Fiji Islands of the South Pacific. This name is sometimes credited to Guérin-Méneville (1829, Icono. Règne Animal, (1), pl. 9, fig. 1) and often to Wagler (1830, Syst. Amph.: 151). Cuvier (1829, Règne Animal, 2(2): 40) in the text of his work uses the name strictly in a vernacular sense. However in the *Iconographie*, edited by Guérin-Méneville, the name is presented in Latinized form. These illustrations were published at intervals during the years 1829 to 1834 with no indication of the exact date of publication for individual plates. The figure bearing the generic appellation *Brachylophus* is on plate nine and was undoubtedly published in 1829. Cuvier was most certainly responsible for the Latin names appearing on the plates and consequently Cuvier's *Brachylophus* antedates Wagler's 1830 usage. Wagler (*loc. cit.*, p. 151) himself refers the genus to Cuvier and states that he knows this lizard only from its illustration and description, definitely establishing the precedence of Cuvier's *Brachylophus*. *Chloroscartes* Günther, 1862 (monotype, *Iguana fasciata* Brongniart, 1780) is a strict synonym of *Brachylophus*. *B. fasciatus* (Brongniart) remains the only known member of the genus.

The Madagascar genus *Chalarodon* Peters, 1854 (monotype, *C. madagascariensis* Peters, 1854) is monotypic, is restricted to the island, and stands without question.

The other Malagasian genus is usually known as *Hoplurus* Fitzinger, 1843 (monotype, *Oplurus sebae* A. M. C. Duméril and Bibron, 1837 = *Tropidurus cuvieri* Gray, 1831, a substitute name for *Oplurus torquatus* Cuvier, 1829). However the name *Oplurus* Cuvier, 1829 (monotype, *O. torquatus* Cuvier, 1829 = *Tropidurus cuvieri* Gray, 1831) has priority. Fitzinger's name is merely an emendation of Cuvier's *Oplurus* and as such cannot be accepted. The type of the genus, *Oplurus torquatus* Cuvier, 1829, is a secondary homonym of *Tropidurus torquatus* Wied-Neuwied, 1821. The first available name for Cuvier's species is *Tropidurus cuvieri* Gray, 1831. *Oplurus sebae* A. M. C. Duméril and Bibron, 1837 was apparently based on the same specimen as Cuvier's *Oplurus torquatus* and must stand as a synonym of Gray's earlier name.

The genus *Oplurus* now contains six species, one of which has two subspecies. These are, *O. cuvieri cuvieri* (Gray), 1831; *O. cuvieri comorensis* (Angel), 1942; *O. cyclurus* (Merrem), 1820; *O. grandidieri* (Mocquard), 1900; *O. saxicola* Grandidier, 1869; *O. quadrimaculatus* (A. H. A. Duméril), 1851; and *O. fierinensis* Grandidier, 1869. Only *O. c. comorensis*, which is found on Comoro and adjacent islands, is extralimital to Madagascar.—JAY M. SAVAGE, *Natural History Museum, Stanford University, California.*

THE DISTRIBUTION OF THE PACIFIC GIANT SALAMANDER, *DICAMPTODON ENSATUS*, EAST OF THE CASCADE MOUNTAINS.—The known range of the ambystomid, *Dicamptodon ensatus*, presents a peculiarly disjunct pattern. The species appears to have a continuous range throughout the humid, transition belt along the Pacific coast from Santa Cruz County, California north to southwestern British Columbia but is also known from three records in the Rocky Mountain region to the eastward.

Cope (1867, Proc. Acad. Nat. Sci. Phila.,: 201) was the first to report a non-coastal *Dicamptodon* when he described a specimen of this species from the "North Rocky Mountains" as *Amblystoma aterrimum*. This is apparently the basis of some authors' reference to the species from the Rocky Mountains of Montana.

Slipp and Slater (1940, Occ. Pap. College Puget Sound, 11: 69) and Slater (1941, *Ibid.*, 14: 84) definitely established the occurrence of the giant salamander in northern Idaho. The first Idaho record was based upon a series of five examples (four larvae and one adult) from Mannering Creek, 12.2 miles north of Harvard, Latah County, into the Benewah County portion of the St. Joe National Forest. The second report was on the basis of three specimens from Rock Run Creek, west of Monumental Peak, Shoshone County. The nearest approach of coastal *Dicamptodon* to these areas lies approximately 260 miles westward across the Cascade Mountains.

Two *Dicamptodon ensatus* (SU 10742–43), recently added to the collections of the Natural History Museum of Stanford University, extend the known range of the species in Idaho approximately 150 miles southeast from the Benewah County locale. The Stanford material is from the South Fork of the Salmon River at a point about 20 miles south of where the Secesh River empties into it and five miles north of Knox, Valley County. This place is in the Payette National Forest of central Idaho approximately 25 miles northeast of Cascade, Valley County.

Both of these specimens are typical *Dicamptodon* larvae with short feathery gills and the extensive, curved palatal dentition supposed by Cope to be characteristic of his *A. aterrimum* but which is present in all larvae of the species and is lost upon transformation. The general coloration is brownish above with the undersides bluish-gray. The upper surfaces of the back and tail show the obscure marbling of this form and the lower lips, gular fold, anal region and mid-ventral line of the tail are light. The larger example (SU 10742) measures 108 mm. in standard length (snout to vent) and has a tail length of 81 mm. The other specimen has a standard length of 88.5 mm. and the tail is 69 mm. long.

The Salmon River record indicates that the Pacific giant salamander has a wider range than had previously been suspected and suggests that the species occurs in other trans-Cascade areas with suitable ecologic requirements. Quite probably the discontinuity of the ranges of the coastal and inland populations of *Dicamptodon* is apparent rather than real, for there are regions between the known ranges which seem favorable to the species. A possible connecting corridor between the two populations may be that area of the International Boundary in northeastern Washington and southeastern British Columbia lying along the southern margin of Dice's (1943, The biotic provinces of North America: map 1) Montanian Province, and east and north from the main ridge of the northern Cascade Mountains. This area has been poorly worked for herpetological materials but is high enough above the dry, adjoining Palusian Province to provide sufficient humidity and low enough to allow migration between the coastal (Oregonian Province) region and known areas of occurrence of *Dicamptodon* in northern Idaho.

Triturus granulosus, *Plethodon vandykei* (the Idaho form is usually considered to be a distinct species, *P. idahoensis*), and *Ascaphus truei*, amphibians which have distributional patterns similar to that of the giant salamander, may have their coastal and Idaho populations connected along this same northern corridor.—JAY M. SAVAGE, *Natural History Museum, Stanford University, California.*

NOTES ON BREEDING AND REPRODUCTION IN THE LIZARD *ANOLIS CAROLINENSIS*.—Since 1947 the writer has been studying the embryology of *Anolis carolinensis*, the so-called American chamaeleon. This has required the collection and examination of several hundred individuals from in and around New Orleans, and has permitted numerous observations on the breeding and reproductive habits of this species, both in the field and in the laboratory. *Anolis* differs remarkably in one respect from any other lizard of which I know, and as this peculiarity seems little known to herpetologists I present here a short description of the outstanding features of its reproductive habits. All my observations were made in the vicinity of New Orleans.

The unique feature found in *Anolis* is a continuous breeding season with the production of single eggs in regular succession. In many lizards there is a brief breeding season in the spring; sometime thereafter the female lays a clutch of eggs (or, in a few species, gives birth to young) all of which are in the same stage of development, and the reproductive activity of the individual is terminated for that year. *Anolis*, on the other hand, breeds at any time from mid-spring until the end of summer, and mature ova are produced throughout the late spring and all of summer. The mature ova are discharged

singly at intervals of about two weeks, take probably 18 to 19 days to pass down the oviducts, and are laid one at a time every two weeks. Even before one egg has completed its tubal journey, a second one has been ovulated and fertilized, so that for a time the oviducts contain two ova, one with the embryo in a relatively advanced stage of development and with its "shell"' chalky and tough, the other in a cleavage, primitive streak, or early somite stage and with its shell membranes soft and free of calcium.

TABLE I

FREQUENCY OF PREGNANT FEMALES IN *Anolis carolinensis*

Date	Number examined	Number pregnant
26 April 1950	3	3
12 May 1950	12	9
18 May 1950	14	13
25 May 1950	12	12
31 May 1950	5	5
23 June 1950	2	2
29 June 1950	1	1
19 July 1950	3	3

bumen and shell membranes likewise shows that one of the eggs has been in the oviduct considerably longer than has the other. The ovaries alternate quite regularly in this continuous and rhythmic egg production, for whenever two eggs are found, there is always one in each oviduct; and when there is but a single egg, then the most nearly mature ovarian egg is always in the contralateral ovary. Finally, eggs discovered in the field are always found singly, rather than in clutches, and numerous observations made on caged lizards show that the female lays but one egg at a time.

While the several lines of evidence cited above indicate that *Anolis* has a continuous breeding season during which it produces many eggs in succession, the determination of the exact rate of this

TABLE II

NUMBER OF *Anolis* FEMALES WITH ONE OR WITH TWO TUBAL OVA, BY MONTH, 1947–1951

Number of ova	April	May	June	July	Aug	Totals
1	13	77	50	3	3	148
2	6	37	25	13	3	76

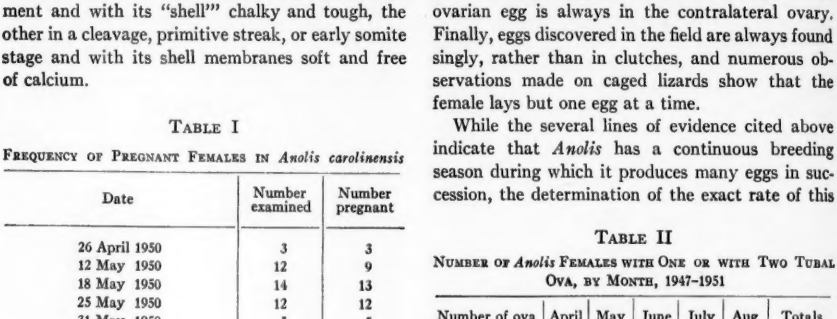


Fig. 1. The rate of egg production by a female *Anolis*, indicated by the results of dissection.

The first hint of this unusual type of reproductive cycle came when examination of females taken over a period of four months showed no decrease in the percentage of pregnancies. Unfortunately, no record was kept until recently of the number of non-pregnant individuals, but virtually every adult female (i.e., with head + body length of 50 mm. or over) taken after May 1 was pregnant, and thus in accord with the 1950 records (Table I). In previous years, females caught as late as the third week of August were also usually pregnant. The presence of pregnant animals all through the summer is not due to a long retention of the egg in the oviduct, for these lizards have been seen to lay as early as April 28.

Another indication that there is a long-drawn-out ovulatory period lies in the fact that females carrying two ova always have them in quite different stages of development; the condition of their al-

ovulation and egg-laying must depend upon more direct observations. My best data come from observations on *Anolis* kept in a vivarium. A male and four females were caught on May 4, 1951 and brought into the laboratory. One female failed to adapt to vivarium conditions and died at the end of the month. The others remained healthy, and by June 29 had laid 15 eggs. Assuming that the dead animal contributed her share during the month she was alive, each lizard produced one egg every 13 days. Since the laboratory temperatures averaged slightly higher than those in the woods during the first month, this rate of laying may be a little higher than normal. I imagine an ovulation every two weeks will be very close to the average for individuals in nature, and this agrees well enough with the stage of development the embryo has reached in any one egg at the time the succeeding ovum is ovulated.

No practical method has as yet been found for observing directly the time required for the egg to traverse the oviduct. This interval between ovulation and oviposition can be determined indirectly, however, from a consideration of the relative numbes of females carrying one egg or two eggs in their tubes (Table II). There is evidently an almost exact 2:1 ratio between the numbers of one-egg and two-egg "pregnancies," which means that any one lizard will be carrying a single egg two-thirds of the time during the breeding season. Now if there is a 14-day interval between ovulations, it can be calculated that the passage down the oviduct must require ½ longer, or 18–19 days, in order that there shall be two eggs in the tubes during ⅓ of this time (Fig. 1).

It seems likely that there is a separate insemination for each egg ovulated rather than any prolonged storage of spermatozoa in the female tract. The males are sexually active from late March through the summer, and pairs have been seen in copula every month of the spring and summer. A male kept in the vivarium with four females has been observed pairing with one or another of them every few days.

Anolis is quite active by late March in the New Orleans area, but no females examined at this time had ovulated. I have found a tubal egg as early as April 7, and by the latter part of April at least half the adult females have ovulated. After May 1 practically all contain tubal eggs and some are already laying. As for the close of the season, I recall having once seen a pregnant female in September; but my latest written record is of a female killed August 19, which had a tubal egg on one side and a mature egg in the opposite ovary. I have not been able to do much field work during the late summer, but the few specimens collected show the assembly line production of eggs still going on. Egg laying thus covers a period of four or five months, with each female laying an egg every two weeks, or slightly oftener, during this time.

At the time of laying, the egg measures 6 or 6.5 mm. in diameter by 10 or 10.5 mm. in length; the yolk and embryo without the shell membranes are 5 x 8 mm. The egg increases slowly in size as it absorbs water from the soil and leaf mould in which the female has half buried it, until at the end of five weeks (at laboratory temperatures) it measures 12 x 17 mm. and is ready to hatch. The newly emerged lizard measures 60–65 mm. in length, of which head and body make up 22–25 mm. It grows rapidly and attains a head+body length of 35–40 mm. before winter. Two size-groups of females can be distinguished the following spring: the young of the previous year, averaging around 40 mm., and adults in their second year, or older, measuring 50–52 mm. in head and body. As the young females reach 45–48 mm. in size, their ovaries begin to mature, and most of these year-old females will ovulate before the summer is over. The young males do not seem to mature until the following year, when they are two years old and have attained a head + body size of 60 mm.—GEORGE W. D. HAMLETT, *Department of Anatomy, Louisiana State University School of Medicine, New Orleans 13, Louisiana.*

OBSERVATIONS ON CRICKETFROG LOCOMOTION.—Observations on *Acris crepitans* Baird in Bucks County, Pennsylvania, may provide a partial explanation for the skittering locomotion of *Acris* as recorded by Blair (1950, COPEIA (3): 237). This diminutive hylid is numerous along the banks of the Delaware Canal. The canal has an average width of 20 feet. When the frogs were disturbed, they exhibited skittering locomotion along the surface for a distance of 3 or 4 feet, then turned and swam rapidly back to the bank. Many specimens left the water and attempted to hide in the grass. On the suspicion that predatory fish were responsible for the skittering behavior, these frogs were used as bait. They were immediately seized by bluegill sunfish (*Lepomis*). An awareness of the presence of fish might account for the rapid locomotion on the part of the frogs.

Cricketfrogs have been collected extensively throughout Bucks County, and field notes indicate that there is a strong tendency for the frogs to remain entirely in the grass or weeds along any body of water. Wherever a suitable habitat is found in pools near a permanent body of water, individuals have been observed there rather than along the main body of water. Individuals have been collected in permanent pools that were 60 yards from the nearest stream.

Rana pipiens along the canal also tends to remain close to the shore line. After jumping into the water, individuals invariably return immediately to the bank; they do not attempt to hide on the bottom of the canal. This action may be due to the presence of largemouth bass (*Huro*). The skittering locomotion of *Acris crepitans* may be attributed to the presence of predatory fish or to an aversion to deep water in preference to a moist habitat offering abundant cover.—ROBERT G. HUDSON, *2248 Taggert St., Philadelphia 25, Pennsylvania.*

NOTES ON THE LATIN AMERICAN SKINK, *MABUYA MABOUYA*.—The skink, *Mabuya mabouya mabouya* (Lacépède) as considered by Dunn (1936, Proc. Acad. Nat. Sci. Philadelphia, 87: 544–46) has a tremendous geographic range and great morphologic variability, entirely out of proportion in both respects to that of other American mabuyas. Moreover, the data presented by Dunn (*loc. cit.*) suggest that within that subspecies certain

characters regularly distinguish populations of one area from those of another.

Data from two series of specimens that I collected in México and Venezuela in 1949 and 1950, respectively, and from others in the University of Illinois Museum of Natural History (UIMNH), the Museo de Ciencias Naturales de Caracas (MCNC), and the Chicago Natural History Museum (CNHM), show that one of the regional variants synonymized by Dunn is a distinguishable subspecies.

More important than the simple revival of a subspecies is the implication that Dunn's (*loc. cit.*) conservative appraisal should be reviewed in its entirety. Variations on the order of those characterizing *M. mabouya sloani* and the subspecies here defined appear to be present in other named populations of the Lesser Antilles and the South American mainland.

Mabuya mabouya alliacea Cope

DIAGNOSIS.—Distinguished from the typical subspecies by (1) the narrow dorsolateral dark stripe, two or less scales in width, as contrasted to 2½ or 3 scales, and (2) the fifth supralabial rather than the sixth centered beneath the eye, on at least one side.

DISTRIBUTION.—México from the states of Veracruz on the Atlantic and Sinaloa on the Pacific coast (Smith and Taylor, 1950, Bull. U. S. Nat. Mus., 199: 156) to Costa Rica. The record for the latter country is in Cope's original description of *alliacea* (Jour. Acad. Nat. Sci. Philadelphia, 1876, New series, 8 (2): 115, pl. 6, fig. 1). This description and that of the Panamanian *unimarginata* (Cope, 1862, Proc. Acad. Nat. Sci. Philadelphia, 16: 176–188) both indicate that the first has the eye over the fifth supralabial and the second has the eye over the sixth. Thus in all probability they represent the Mexican subspecies and the subspecies of northern South America, respectively. The specimens upon which the present concept of *alliacea* is based are listed by locality below.

MÉXICO.—*Campeche*: Balchacaj (UIMNH 22586–7, 22590, 22593); El Encarnación (UIMNH 22591–2); Tres Brazos (UIMNH 22588–9). *Chiapas*: Benito Juarez (UIMNH 8656); Fenix, 3 mi. NW of Monserrate (UIMNH 8653); La Trinitaria, 13 mi. S of (UIMNH 8665); Rancho Monserrate (UIMNH 8154–5); Rancho San Bartolo (UIMNH 8557–64); Tapanatepec, 1 mi. E of (UIMNH 8666–7). *Colima*: Manzanillo (CNHM 1650); Paso del Rio (CNHM 1673). *Guerrero*: Agua del Obispo (UIMNH 22559, 22569–70); Chilpancingo (UIMNH 22560–1, 22595); El Limoncito, near Acapulco (UIMNH 22562–8); Omilteme (UIMNH 22571). *Michoacán*: Hacienda El Sabino, Uruapan (UIMNH 22572–85). *Oaxaca*: Tehuantepec (UIMNH 11012–9, 11021, 11024, 22594); Puerto Angel (UIMNH 8652). *Yucatán*: Chichen Itza (CNHM 49320–1); Tekon (CNHM 49319); no definite locality (CNHM 547).

CENTRAL AMERICA.—*Guatemala*: no definite locality (CNHM 285). *El Salvador*: Divisadero (CNHM 10972). *British Honduras*: Belize (CNHM 4190–5, 4457–8); Stann Creek Valley (CNHM 49316–8). *Honduras*: Jaral, Lake Yojoa (CNHM 5062); Lake Ticamaya (CNHM 5061); San Pedro (CNHM 5060); Siguatepeque (CNHM 5063); Tegucigalpa (CNHM 5064–5).

Mabuya mabouya mabouya (Lacépède)

Data presented by Dunn (*loc. cit.*) indicate that the pattern of variation in northern South America and the Lesser Antilles is very complicated. The type locality of Lacépède's *Lacerta mabouya* has been restricted to St. Vincent, Lesser Antilles by Smith and Taylor (1950, Univ. Kansas Sci. Bull., 33 [2] (8): 31). If for the moment this restriction is assumed to be tenable, considerable doubt accompanies the association of the mainland population with it. However, not having any direct evidence to the contrary, I follow Smith and Taylor in the name restriction and Dunn in its application to populations of northern South America. A list of the specimens examined by me follows.

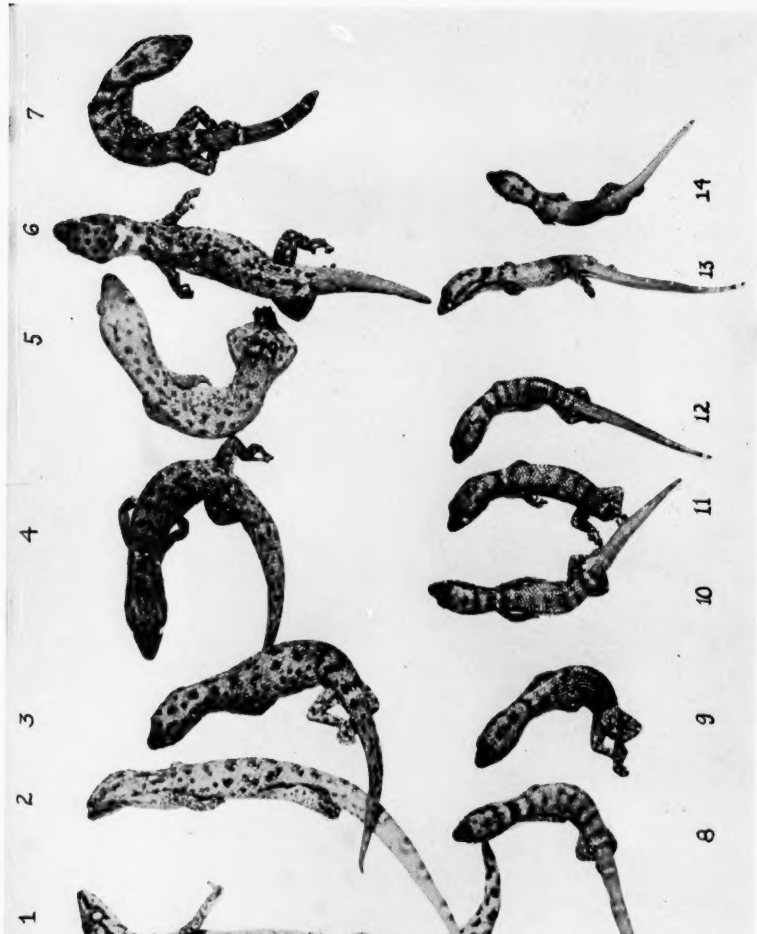
PANAMA CANAL ZONE.—Barro Colorado Island (CNHM 56473, 13363–4).

COLOMBIA.—Villavicencio (CNHM 30577–9). *Antioquia*: Nechi, Cauca River (CNHM 55961–2). *Bolivar*: San Juan Nepomuceni (CNHM 61184).

VENEZUELA.—*Aragua*: Colonia Tovar (UIMNH 22269, MCNC 152); Rancho Grande (MCNC 150–1). *Delta Amacura*: Araquai-Mujo (UIMNH 22265); San Francisco de Guaio (UIMNH 22266–7, MCNC 146–9); Tucupito (UIMNH 22264, MCNC 145).

VARIATION

Only four characters were used in this study: number of pairs of nuchals, relationship of the supranasals, position of the eye in relation to the supralabials, and width of the dorsolateral dark stripe. Other characters, particularly the number of rows of scales around the body and the number of scales from snout to vent, may throw light on geographic variation and subspeciation in *Mabuya mabouya*; however after initial trials in the present survey they were disregarded. The number of scales around midbody in a series of nine specimens from Tehuantepec, México and fourteen from northern Venezuela are identical in range (28–32) and have virtually identical arithmetic means (Venezuela: 29.93 ± 0.32, $\sigma = 1.22 \pm 0.23$; Tehuantepec: 29.89 ± 0.40, $\sigma = 1.19 \pm 0.28$).



Pattern changes in *Sphaerodactylus difficilis*
Figs. 1–4, adult females; Figs. 5–7, adult males; Figs. 8–14, juveniles

Of the four characters studied in detail, the first two listed above were of little value. In *Mabuya mabouya*, throughout the area studied, a single pair of nuchals is the normal condition. The exceptional condition of two pairs occurred once in each of two series numbering 24 *M. m. alliacea* and 9 *M. m. mabouya*, respectively. In the area from the Isthmus of Panama southward, that is within the subspecies *mabouya*, the supranasals are almost consistently in broad contact. However in *M. m. alliacea*, which ranges to the north of the Isthmus, the arrangement of supranasals is more variable. In Central America north to México and including the Atlantic coast states of Yucatán and Campeche, the supranasals are in broad contact in 75 to 85 percent of specimens. In Chiapas approximately 50 percent of the specimens have the supranasals in contact; and to the north in Oaxaca and Guerrero this is true in only 20 to 25 percent. Although these data suggest a northern Pacific coast subspecies, no other character parallels the supranasals, and the percentage reverts again in Colima and Michoacán to 89. Consequently the populations represented by the last series are, to my knowledge, impossible to separate from the populations extending southward from Yucatán and Campeche to the Isthmus of Panama. This situation deserves closer study when larger series of freshly preserved specimens become available.

The two remaining characters, width in scales of the dorsolateral dark stripe and ordinal number of the supralabial underlying the eye, form the basis of the present subspecific distinction. The percentages of separation of *M. m. mabouya* from *M. m. alliacea* by the respective characters is 97 from 83 and 85 from 74, both well above the 70 mark usually required by herpetological taxonomists (Table I).

This paper is a contribution from the Museo de Ciencias Naturales de Caracas and the University of Illinois Museum of Natural History.—W. Leslie Burger, *Museum of Natural History, University of Illinois, Urbana, Illinois.*

TABLE I

VARIATION IN THREE CHARACTERS OF *Mabuya mabouya*

The width of the dorsolateral dark stripe is given in terms of the number of longitudinal scale rows involved; the supralabial under the eye is the ordinal number; the mutual relationship of the supranasals is expressed as separated (S), touching (T), or in broad contact (BC)

Geographic origin	Width of dorsolateral dark stripe				Supralabial under eye			Relationship of supranasals		
	1½	2	2½	3	5-5	5-6	6-6	S	T	BC
m. alliacea										
Colima and Michoacán	0	17	0	0	12	0	5	1	1	16
Guerrero	0	12	1	0	12	0	1	8	2	3
Oaxaca	2	11	1	0	5	1	0	8	3	3
Chiapas	0	16	1	0	15	0	1	7	3	7
Campeche and Yucatán	1	10	0	1	11	1	1	3	0	9
Guatemala and Br. Honduras	0	12	0	0	11	1	0	3	1	8
Honduras and Salvador	1	5	0	0	4	1	1	1	0	5
m. mabouya										
Panama Canal Zone	0	1	1	1	0	1	2	0	0	3
Colombia	0	2	2	2	2	0	4	0	0	6
Venezuela	0	1	3	10	4	3	7	1	0	13
Total										
m. alliacea	4	85	3	1	70	3	9	31	10	51
m. mabouya	0	4	6	13	6	4	13	1	0	22
Percentage of separation	*alliacea* 97		*mabouya* 83		*alliacea* 85	*mabouya* 74				

SEXUAL AND GROWTH CHANGES IN THE PATTERN OF THE GECKO *SPHAERODACTYLUS DIFFICILIS* BARBOUR.—Seven adults and seven juveniles of this species were taken at La Romana in southeastern Santo Domingo by the writer in December, 1946 (Plate I, Figs. 1–14).

This gecko shows a growth pattern change similar to that of *S. cinereus* (1948, Jour. Ento. and Zool., 40: 69–71, 2 pls.). The escutcheon of the male is very much reduced in size compared to other species of the genus and has no extension onto the thighs. The color of the adult consists of a light tan background, with large brown spots on the upper surfaces. The sub-adults retain the stripes across the tail, whereas the young are cross-striped except on the head and neck. The series is not large enough to determine whether the nuchal "mask" disappears with age, or is an individual or sexual pattern.

Pattern changes in *Sphaerodactylus difficilis*
Figs. 1–4, adult females; Figs. 5–7, adult males; Figs. 8–14, juveniles

The change in pattern is from cross-banded young to spotted adult. One female (Fig. 4) and one male (Fig. 7) retain the juvenile pattern on the head. These two specimens and another female (Fig. 2) have also retained the two white spots on the shoulders which are always present in juveniles. Perfect tails end in a tiny black tip, preceded by a white ring and a black one. This is apparent in a female (Fig. 2) and three juveniles (Figs. 12–14). The tail pattern of white bands outlined in black is apparently variable in perfect tails, but never present in regenerated ones. The tails of the juveniles are coral red.—CHAPMAN GRANT, *2970 Sixth Avenue, San Diego 3, California.*

THE CROWNED SNAKE, *TANTILLA CORONATA CORONATA*, IN NORTH CAROLINA.—The most recent account of the herpetology of North Carolina (Brimley, 1939–43, Carolina Tips) lists only three records of the crowned snake from the state, with the comment that it "seems quite rare." Brimley records the species from Wake, Moore and Duplin counties, all of which are on the coastal plain or along the Fall Line. Recent investigations of major collections reveal that the species is more abundant than formerly supposed and is widely distributed within the state.

Two specimens (Nat. Hist. Soc. of Maryland, Nos. 1552–53) were collected on April 25, 1949, about two miles northwest of Elon College, Alamance County, in the central Piedmont section. The specimens were located by digging up old pine stumps in a small, cleared field of reddish-brown clay. They were found among the small roots of the extracted stumps, and had apparently come from 12 to 18 inches below the surface. Another example (NHSM 1562), taken in the same field on April 9, 1949, is reported to have been taken in the same manner. Insect larvae were abundant around the stumps at which the snakes had been collected; earthworm burrows were also numerous. Plowing the field, in search of other specimens, revealed two brown kingsnakes, *Lampropeltis calligaster rhombomaculata.*

D. L. Wray, of the Department of Agriculture, Raleigh, North Carolina, informs me that he has collected *Tantilla* in a suburban yard in Raleigh. He has observed numerous specimens, and deposited three in the collection of the North Carolina State Museum at Raleigh. They were secured by digging up roots and stumps in "new ground" near the edge of a garden located in a hardwood area, and were found about one foot beneath the surface of the soil.

Mr. Anton F. Baarslag, of New Rochelle, New York has collected the crowned snake in western North Carolina at Roundtop Mountain on the border of Henderson and Rutherford counties. His field notes reveal that this species was found in a cleared field, from which the rocks had been removed and piled along the edges, located on the southeastern slope of Roundtop Mountain. Individuals were discovered beneath the rocks and seemed to be quite abundant. Five specimens (American Mus. Nat. Hist., Nos. 66207–11) were collected within thirty minutes on June 15, 1945; two were found beneath a single rock. The absence of a completely subterranean existence was also noted in more eastern localities where surface cover was not so available.

The following reptiles were observed in the same field from which the crowned snakes were obtained: *Anolis carolinensis* (very abundant), *Heterodon p. platyrhinos, Lampropeltis doliata triangulum, Carphophis amoena, Agkistrodon contortrix mokeson* and *Crotalus h. horridus.*

Smith (1946, Handbook of Lizards) states that *Anolis carolinensis* is found "mainly in the Coastal Plain." Neither *Anolis carolinensis* nor *Tantilla c. coronata* is generally regarded as a montane form, and their co-existence at Roundtop Mountain may indicate Piedmont affinities of the area. Mr. Baarslag examined and released a specimen in a pile of bark slab at an abandoned lumber yard about 4 miles south of Norlina, Warren County, in the Piedmont area.

Other records of *Tantilla c. coronata*, all from the coastal plain and Piedmont plateau, are as follows: Beaufort (Museum of Comparative Zoology, No. 1345); Brunswick County, 12 miles south of Wilmington (Carnegie Museum, No. 21542); Sampson County, Clinton (N. C. State Museum, no number); Gilford County (Biology Department, Elon College, no number).

Tantilla coronata coronata has also been reported from Tennessee (very near the North Carolina line) and from Virginia where it is apparently rare. —JERRY HARDY, JR., *Natural History Society of Maryland, Baltimore, Maryland.*

SOME COMMENSAL RELATIONS OF THE LIZARD *CNEMIDOPHORUS SEXLINEATUS* (LINNE).—Commensalism, as used by Allee *et al.* (1949, Princ. Anim. Ecol.), involves relations that are beneficial to at least one and harmful to neither partner of a cooperative association. We wish to present a new example of this concept as represented by host-guest associations of the teiid lizard *Cnemidophorus* and the mouse *Peromyscus polionotus.* This is apparently on the nonspecific behavior level, since *Cnemidophorus* has been reported associated with gopherturtle (*Gopherus polyphemus*) burrows (Deckert, 1918, COPEIA, 54: 31; Hallinan, 1923, COPEIA, 115: 19; Carr, 1940, Univ. Fla. Pub. Biol. Sci. Ser., 3 (1): 74). There are a few records of the western forms of this lizard digging their own bur-

rows, or at least living in burrows presumably made by the lizards themselves (Park, 1918, COPEIA, 56: 51; Burt, 1932, *ibid.*, (3): 158; Tevis, 1944, *ibid.*, (1): 15).

On September 11, 1951, we investigated about 40 *P. polionotus* burrows in the Sand Pine-Scrub Association of the Ocala National Forest, Marion County, Florida. The burrow of this mouse is about 1½ inches in diameter and extends at a slight angle to a depth of about 2 feet where it widens to form a globose nest chamber approximately 8 inches in diameter. From here a tunnel extends almost vertically to within an inch of the soil surface. This tunnel serves as an escape route in times of danger. These burrows are similar to those described by Hayne (1936, Jour. Mammal., 17 (4): 420–21).

At least a third of the mouse burrows that we opened had lizard tracks leading into them, regardless of whether or not *Peromyscus* was inside. On two occasions a *Cnemidophorus* entered a *Peromyscus* burrow as we approached. In both, when we began to dig at the opening, a lizard burst from the sand about a foot from the burrow. Closer examination showed that the lizard went into the burrow to a depth of nearly 4 inches, at which point the burrow is usually plugged. Here the lizard had previously dug a side tunnel perpendicular to the mouse burrow and slanting upward almost to the soil surface. When disturbed, the lizard escaped from its side tunnel by bursting through the soil. Thus the lizard and the mouse have similar means of escape.

From these observations, it appears that the lizard obtains improved shelter conditions by use of the mouse burrow, and that there is no harm inflicted on the mouse.—PAUL G. PEARSON AND GID E. NELSON, JR., *Department of Biology, University of Florida, Gainesville, Florida.*

THE SOUTHERN RANGE OF THE RACER *COLUBER CONSTRICTOR STEJNEGERIANUS* (COPE), WITH REMARKS ON THE GUATEMALAN SPECIES *COLUBER ORTENBURGERI* STUART.—In spite of the works of two recent authors, the range of the dwarf racer, *Coluber constrictor stejnegerianus,* is still poorly known. In 1895, Cope (Amer. Nat., 29: 676–780) described the racer *Zamenis stejnegerianus* from Brownsville, Texas, and another species, *Zamenis conirostris* from Matamoros, Tamaulipas. Ortenburger (1928, Mem. Univ. Michigan Mus. Zool., No. 1) later synonymized both forms with the subspecies *Coluber constrictor flaviventris.* In 1942, Mulaik and Mulaik (COPEIA, (1): 13–15), revived *Zamenis stejnegerianus* under the name *Coluber constrictor stejnegerianus,* extending its range to include the Lower Rio Grande Valley of Texas. In a more extensive study of this subspecies, Auffenberg (1949, Herpetologica, 5: 53–58) extended the range to "... embrace the Gulf Coast from Matamoros, Tamaulipas, northwestward to approximately northern San Patricio County, Texas."

Recent collecting in Gulf Coastal Veracruz by Dr. Norman Hartweg and the author has resulted in a considerable southerly range extension of *Coluber c. stejnegerianus* in México. On July 4, 1941, a juvenile female, UMMZ 9080, was collected by Dr. Hartweg 4 miles west of the city of Veracruz. Head scales are normal for the subspecies except that both prefrontals are split laterally, a character also observed in *Coluber oaxaca* (1890, Dumeril and Bocourt, Miss. Sci. Mex., p. 701, pl. 43, fig. 2). Supralabials are 8–8, the fourth and fifth entering the orbit and the second and anterior part of the third bordering the loreal. The scale formula is $17\frac{-4(86)}{-4(86)}15$ (162). Subcaudals are 81. The body measures 150 mm., and the tail 84 mm. The juvenile pattern is like that described by Auffenberg (*loc. cit.*), consisting of 58 narrow black cross bars, formed by fused rows of spots, from one to two scale lengths wide. The last four of five cross bars are very irregular. On the anterior two-thirds of the body, the ground color is pale grey-green, the sides are spotted with black and there are two black spots on the lateral edges of the ventrals. The ventrals are unspotted on the posterior one-third of the body, as are the subcaudals, and the dorsal ground color fades to light tan posteriorly. The venter is whitish.

On September 3, 1951, a small adult male, UMMZ 103315, was collected by the author one mile west of Tecolutla, also in the state of Veracruz. The head scales are normal, supralabials 8–8. The scale formula is $17\frac{-4(84)}{-4(85)}15$ (161). Subcaudals are 90. The color is a uniform greenish-grey above, becoming somewhat lighter posteriorly, and a pale yellow below. The Tecolutla and Veracruz City records are, respectively, 374 miles and 405 miles south of Matamoros, Tamaulipas.

The occurrence of *Coluber constrictor stejnegerianus* as far south as the city of Veracruz poses an interesting problem as to its relationships with the Guatemalan species, *Coluber ortenburgeri* Stuart (1934, Occ. Pap. Mus. Zool. Univ. Michigan, No. 284) and *Coluber oaxaca* Jan. *Coluber ortenburgeri* is still known only from the type, taken near La Libertad, in El Peten, Guatemala, or about 465 miles east southeast of Veracruz City. In the type description, Stuart states "... my decision to place it (*ortenburgeri*) in the genus *Coluber* is purely tentative," and he lists, as reasons for its possible affinities with the genus *Masticophis,* the long tail and eight supralabials, the reduction of the dorsal scales from 17 to 15 rows by loss of the fourth rows,

and from 15 to 14 rows by loss of the vertebral row. It has been shown that a count of eight supralabials is normal for *C. c. mormon* and *C. oaxaca* (Ortenburger, *op. cit.*), and also for *C. c. stejnegerianus*, (Auffenburg, *op. cit.*). It has also been shown that reduction from 17 to 15 scale rows by loss of the fourth rows is usual for all subspecies of *Coluber constrictor*. Furthermore, the tail is not longer than that of any American form of *Coluber*, being 20.2 percent in the type of *C. ortenburgeri*, 23.3 in *C. oaxaca*, and averaging 24.0 in *C. c. flaviventris*, 24.9 in *C. c. constrictor*, 26.8 in *C. c. mormon*, and 26 in *C. c. stejnegerianus*. (Subcaudal count of the type of *C. ortenburgeri* is given as 95+, but an examination of the type shows that two or three additional subcaudals at the most could have been present.) Reduction of scale rows from 15 to 14 by loss of the vertebral row is characteristic of the genus *Masticophis*, however, and examination of the type of *C. ortenburgeri* revealed that the vertebral row is lost four times, above the 129th, 136th, 144th and 146th ventral, and regained above the 131st, 138th and 145th ventral. This condition is typical of neither genus, but was found in two of eleven *C. c. stejnegerianus* examined, and a similar condition has been reported in *Coluber oaxaca* (1945, Smith and Taylor, U. S. Nat. Mus. Bull. No. 187). It seems likely that such an unusual scale reduction is abnormal. Thus there seems to be little doubt that *C. ortenburgeri* was correctly placed in the genus *Coluber*.

At the time of Stuart's description, *C. c. stejnegerianus* was hardly known, and he was led to believe "... the species (*ortenburgeri*) is closest to *C. c. mormon* if it is to be placed in the genus *Coluber*." It now seems clear that its affinities lie, rather, with *C. c. stejnegerianus*. Comparisons (Table I) of the critical characteristics for differentiating these forms were obtained as follows: the characters for *C. oaxaca* were taken from an account of the only known male of that species by Dunn (1933, COPEIA, No. 4); those for *C. c. mormon* are from Ortenburger (*op. cit.*); ventral and subcaudal counts for *C. c. stejnegerianus*, from Auffenberg (*op. cit.*); maxillary teeth counts and position of 4th scale row reduction in *C. c. stejnegerianus* were taken from 11 southern Texas specimens collected by Mulaik and Mulaik, now in the collection of the Chicago Academy of Science (Nos. 4493, 5270, 5271, 6710, 6712, 6710, 6714, 6713, 6525, 6526, and 9050).

It is apparent, then, that *Coluber ortenburgeri*, although only tentatively placed in the genus by its author, is well established generically. Furthermore, with our more complete knowledge of the variation and range of *C. c. stejnegerianus*, it is clear that the affinities of *C. ortenburgeri* are with that subspecies rather than with *C. c. mormon*. *Coluber ortenburgeri* may be distinguished from *Coluber oaxaca* by the lack of any scale reduction in the latter species in which scale rows are 15 throughout. The similarity between *Coluber ortenburgeri* and *Coluber constrictor stejnegerianus* is apparent. Maxillary tooth count is the same, and ventral and subcaudal counts of *C. ortenburgeri* are very close to the averages for *C. c. stejnegerianus*. A similar loss and regain of the vertebral row was found in two of eleven *C. c. stejnegerianus* examined, and the position at which the 4th scale rows in *C. ortenburgeri* lie is within the range of variation (40.1 – 57.5) found in *C. c. stejnegerianus*. In view of the above data and the geographic range of the form, it seems probable that *Coluber ortenburgeri* is at the most a subspecies of *Coluber constrictor*, closely related to *Coluber c. stejnegerianus*.

TABLE I

CHARACTERISTICS OF *Coluber ortenburgeri*, *C. c. stejnegerianus*, *C. c. mormon* AND *C. oaxaca*
(RPR = relative position of reduction; obtained by dividing mean position of 4th scale row loss by total number of ventrals)

Species	Ventrals (♂♂)	Caudals (♂♂)	Maxillary teeth	RPR
ortenburgeri	157	95+	16	45.8
c. stejnegerianus	159	98	16	50.9
c. mormon	170	92	13–14	57.9
oaxaca	165	102	16	—

I am grateful to Drs. Norman Hartweg and L. C. Stuart for their valuable suggestions in the preparation of this paper.—RICHARD E. ETHERIDGE, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

A NEW SIZE RECORD FOR THE EASTERN GARTERSNAKE, *THAMNOPHIS SIRTALIS SIRTALIS* (LINNAEUS).—Conant's record (1938, Amer. Mid. Nat., 20 (1): 102) of 44 inches for the eastern gartersnake, *Thamnophis sirtalis sirtalis*, based on an Ohio female, has stood for 14 years as the greatest length known to be attained by this form. A female from the collection of the Highland Park Zoological Gardens (PZ 714) was killed recently due to a skin infection, and before preservation was found to measure 1195 mm. (47 in.) in total length, 233 mm. (9.1 in.) in tail length. Although locality data are lacking, the specimen, received from E. Ross Allen on April 6, 1950, was probably collected in Florida. The fact that she gave birth to 14 full term young on May 31, 1950, lends support to the belief that she was of southern origin, since northern females rarely produce litters before July 1.

During the 18 months that this snake was in the collection, it ate 57 smelt (*Mallotus*) with a total

weight of approximately 2,000 g., 22 leopardfrogs (*Rana p. pipiens*) totaling about 1165 g., one small *Bufo terrestris americanus*, one *Necturus m. maculosus*, and one *Ambystoma tigrinum*, a total of approximately 3,385 g.

The specimen has been deposited in the Carnegie Museum (CM 29733).—A. J. BARTON, *Highland Park Zoological Gardens, Pittsburgh 6, Pennsylvania.*

VARIATION IN THE GREENSNAKE, *OPHEODRYS VERNALIS* (HARLAN), FROM THE BLACK HILLS, SOUTH DAKOTA.—In June and July, 1948, William C. Dilger, Frederick K. Hilton and the writer studied the birds and mammals of the Black Hills and made every effort to collect the few reptiles and amphibians which were encountered. Five specimens of *Bufo w. woodhousei*, two *Rana pipiens*, two *Pseudacris nigrita*, four *Thamnophis ordinatus parietalis*, one *Thamnophis radix*, two *Thamnophis elegans vagrans*, one *Lampropeltis doliata*, four *Storeria occipito-maculata* and ten *Opheodrys vernalis* were taken.

The status of the greensnake in the Black Hills has already been mentioned by Grobman (1941, Misc. Pub. Mus. Zool., Univ. Michigan, 50: 20). He found that two males from the Black Hills and a female from Natrona County, Wyoming had fewer ventral and caudal plates than specimens of *Opheodrys vernalis blanchardi* from eastern South Dakota, Nebraska and Iowa, and that in this respect they more closely resembled *Opheodrys v. vernalis* of northeastern United States. Grobman clearly shows this situation on his map (*op. cit.*, 38).

Our collection of ten specimens of the greensnake from the Black Hills is thus of especial interest. One male was collected on July 28 along the shore of Deerfield Lake in western Pennington County, and five males and four females were collected on the same date in Lawrence County 4 miles south of Lead on the road to Rockford. Both these areas are heavily forested with spruce and deciduous trees, and bogs are numerous.

The data on the present collection from the Black Hills have been augmented through the kindness of Dr. Grobman who supplied information on three snakes from the same locality and on one other from Natrona County, Wyoming.

A comparison of *O. v. vernalis* and *O. v. blanchardi* with the Black Hills' series (including the data on the Wyoming specimen) shows no differences in the postocular, labial or scale row counts. However, the ventral and caudal counts of the Black Hills' series are low (Table I), as were those of the two specimens available to Grobman. While the Black Hills specimens seem somewhat intermediate in the ventral count, they average fewer caudal plates than both *blanchardi* and *vernalis*. If additional specimens indicate that the caudal count of our ten specimens is a representative sample, the Black Hills population should not be interpreted as an intermediate one between *vernalis* and *blanchardi*; its affinities are closer to *vernalis* which is the geographically distant but ecologically similar form. It is here considered as a "race" (a category below a subspecies) of *O. v. vernalis*. It is suggested that *O. v. blanchardi*, a form apparently better adapted to life on the plains, has moved up through the Dakotas and has replaced *O. v. vernalis* in this open country, thus cutting off the Black Hills population from the bulk of the subspecies to which it appears to be more closely related. This population had differentiated toward a form with more ventrals but fewer caudals. How extensive an area this form occupies and whether it is deserving of nomenclatorial recognition remains to be demonstrated.

TABLE I
VENTRAL AND CAUDAL COUNTS IN *Opheodrys vernalis*

Characters	*O. v. vernalis*		*O. v. blanchardi*		Black Hills series	
	Males	Females	Males	Females	Males	Females
Ventrals						
Average	123.7 ±.24	132.1 ±.25	134.4 ±.54	144.5 ±.66	126.6	137.8
Range	116–137	121–144	125–141	139–154	123–132	134–144
Number of specimens	203	268	31	31	8	5
Caudals						
Average	84.8 ±.35	73.2 ±.35	88.3 ±1.0	75.0 ±.68	81.8	66.8
Range	74–95	60–89	78–95	68–82	77–86	63–70
Number of specimens	181	210	28	28	8	5

The red-bellied snake, *Storeria occipito-maculata*, is widespread in the area inhabited by *O. v. vernalis*, and is generally absent from the range of *O. v. blanchardi*, but is present in the Black Hills. Here it was found near Lead under the same rocks with the greensnake (Trapido, 1944, Amer. Midl. Nat., 31 (1): 20).

All specimens, except two *Bufo w. woodhousei* which are in personal possession of William C. Dilger, have been deposited in the Cornell University collection. The writer is indebted to Max Hen-

sley for confirming the various counts and sex determinations, to Edward C. Raney for suggestions concerning the manuscript, and to Arnold B. Grobman for advice and data.—C. RICHARD ROBINS, *Conservation Department, Cornell University, Ithaca, New York.*

NOTES ON THE SPADEFOOT TOAD *SCAPHIOPUS H. HOLBROOKI.*—A considerable amount has been written concerning the natural history of *Scaphiopus h. holbrooki* (Harlan), but there appears to be a paucity of information relative to the young after they have metamorphosed and left the breeding pools.

In the late afternoon of June 3, 1951, we took three young spadefoot toads from a locality known as Sally's Rock, at the confluence of Gasper and Barren rivers, in Warren County, Kentucky.

Two specimens, with snout-vent lengths of 26 and 26.5 mm., were taken from an oak-hickory-beech forest on a well-drained limestone bluff overlooking Gasper River. Both individuals were found hopping on the rocky forest floor. A light rain had fallen throughout the night of June 2 and stopped about noon June 3. A third individual, 28.5 mm. in snout-vent length, was found on the night of June 3 hopping across a graveled drive leading to a summer cabin.

Dr. L. Y. Lancaster, who spends considerable time at Sally's Rock, informed us that the only known breeding site in the locality is about three-fourths of a mile from the area where we took the two specimens and about a half-mile from the site of capture of the third individual. Blair (1949, COPEIA, (1): 72) recorded the taking of two young *Scaphiopus holbrooki hurteri*, one of which measured 9.7 mm. in body length, from an opened burrow of *Geomys breviceps*, which was one-fourth of a mile from the nearest breeding pool. Dr. Lancaster also informed us that in 1950 he found a spadefoot, approximately the same size as our specimens, which had burrowed into a pile of dry, crushed limestone. On July 24, 1948, he uncovered three spadefoot toads while moving some earth at the rear of his cabin at Sally's Rock. One of these, measuring 40.5 mm. in snout–vent length, was taken approximately a foot beneath the surface of the soil, underneath a limestone rock that itself was completely buried. These three individuals were approximately one-half mile from the known breeding area.—ROGER W. BARBOUR AND WILLIAM L. GAULT, *Department of Zoology, University of Kentucky, Lexington, Kentucky.*

NEOTENY AND THE UROGENITAL SYSTEM IN THE SALAMANDER *DICAMPTODON ENSATUS* (ESCHSCHOLTZ).—Neoteny has been ascribed to the western marbled salamander by several workers. Henry and Twitty (1937, COPEIA (1): 247–50) reviewed earlier work done by Storer whom they found to be one of the first. Jewett, Graff and Gordon (1939, COPEIA (2): 101–102) found, in larvae of 250–300 mm., fully developed sex organs; a female had eggs apparently fully matured and ready for laying. For any further advance toward a solution of this problem, histological technique was deemed necessary.

Twelve (five males, seven females) larval *Dicamptodon ensatus*, ranging from 11.3 to 25.5 cm., were used for this study, plus one triply injected *Necturus maculosus* (29 cm.) for comparison. As is well known, the size and position of the gonad in *Necturus maculosus* is in conformity with other urodeles. It is situated dorsad to the intestine and ventrad to the kidney. The kidney, a true mesonephric type, is connected to the testis by the vasa efferentia. Portions of the kidney have taken up the function of transporting reproductive products; in the males of *Necturus* the sperm originate in the testis, pass into the kidney by way of the vasa efferentia, traverse the glomerular capsule to larger tubules, empty into the Wolffian duct, and are discharged into the cloaca.

In contrast to this, *Dicamptodon* has a much smaller, compact kidney which lies next to the cloaca and is well separated from the tip of the gonad. Mullerian and Wolffian ducts pass along the ventral crest of the kidney and continue craniad just past the gonad. Here, numerous small tubular connections are formed between the gonad and the Wolffian duct directly. Where the Wolffian duct passes the crest of the kidney there are many tubular connections, and these are always directed back toward the bladder. It appears that the course of the sperm is from the testis through tubules and the Wolffian duct directly into the cloaca. This type of sperm passage is found in higher forms of vertebrates.

Limited histological examination of the testes of the larvae of *Dicamptodon* revealed the following data. Meiotic and mitotic figures were observed, and chromosomal configurations could be seen. Primary spermatocytes were apparently in the packytene stage of prophase during reduction division. Darker staining cells were considered to be metaphase figures. What appeared to be spermatids were also observed. Since metamorphosis in *Dicamptodon* is likely favored by a hot, dry spell usually late in the summer season, it follows that these larvae, taken in October, 1949, in which spermatogenesis is almost completed, would have functional sperm long before metamorphosis occurs. It is the writer's considered opinion that by early spring the spermatids would develop into functional sperm. Also, it is possible that mature sperm were present in the reproductive tract of these animals, but were not found in this preliminary investiga-

tion, due to the difficulty of obtaining fresh or properly fixed material.

The following summary may be made from this preliminary work: (1) The kidney of *Dicamptodon ensatus* is smaller, more compact, further developed, and different in position and internal structure than that of *Necturus maculosus*. (2) The transportation of sperm utilizes only the Wolffian duct, a condition common in amniota. (3) Since spermatogenesis had proceeded almost to completion, it is believed that the larvae examined were neotenic. Histological examinations of fresh specimens taken in the early spring should show active sperm somewhere in the tract.—MICHAEL N. DE MARCO, *Department of Biology, University of Oregon, Eugene, Oregon.*

A LARGE BULLSNAKE, *PITUOPHIS CATENIFER SAYI*, FROM TEXAS.—The largest bullsnake on record (1941, Schmidt and Davis, Field Book of Snakes of the United States and Canada: 164) measured 7 feet, 8 inches in length. On May 21, 1949, I found a dead female on the road, 4 miles east of Brownwood, Brown County, that measured 9 feet.—PFC. JAMES R. DIXON, *HMR-161 M. C. A. F., Santa Ana, California.*

WATERSNAKE KILLED BY HORNED POUT.—On August 5, 1951, I saw what appeared to be a watersnake (*Natrix s. sipedon*) sunning itself on Hoar's Dam, Concord, Massachusetts. The reptile, however, proved to be dead, having swallowed, head first, an eight-inch horned pout. The fish's longest dorsal spine had pierced the snake's gullet and projected externally for about an inch. The snake, which I have presented to the Museum of Comparative Zoology, proved to be a ♀ (MCZ 51650) and measured 1140 mm. in total length.—RICHARD STAFFORD, *Biological Laboratories, Cambridge, Massachusetts.*

THE COAL SKINK, *EUMECES ANTHRACINUS* (BAIRD), IN MARYLAND.—The coal skink has previously been recorded from Maryland on the basis of three specimens, two of which, labeled "Allegany County, Maryland," are deposited in the collection at the Academy of Natural Sciences of Philadelphia. The other, labeled "Mt. City Gap, Maryland," is in the collection at Cornell University (Taylor, 1935, Univ. Kansas Sci. Bull., 23: 386). McCauley (1940, COPEIA (1): 50) has shown that the latter record is actually from Georgia. He (1945, The reptiles of Maryland and the District of Columbia: 41–42) has also indicated that this species "should be looked for further in suitable localities anywhere from the Blue Ridge west upon the Alleghany Plateau. I consider it especially likely to occur in the swamps and glades of Garrett County."

Recently, specimens have been collected on the Alleghany Plateau, as predicted by McCauley, which more definitely establishes *anthracinus* as indigenous to the herpetofauna of Maryland. A female (NHSM-R 1297), measuring 59 mm. (snout to vent), was collected at Swallow Falls State Park, Garrett County, Maryland, on May 29, 1949, by Robert Lambert and Anthony Marsiglia. This individual, which contained seven eggs, was discovered beneath a large rock covering a small pool of water. Previously, on September 5, 1948, in the same area, the senior author had observed a specimen under a slab of wood on a small mound surrounded by moss.

On September 3, 1949, this area was revisited by the authors, and two additional *anthracinus* were captured. The first (NHSM-R 1578), a young specimen measuring 26 mm. (snout to vent), was discovered in a sandy rockpile beneath a small rock which was imbedded in moss. The second (NHSM-R 1579), which measured 56 mm. (snout to vent), was found in a similar situation.

Generally speaking, the area in which these skinks were discovered is boggy, with moss the predominating vegetation. This bog, extending over an area slightly less than an acre, is underlain with small pools and streams; stones and pieces of wood are abundant and a dirt road bordered by trees runs through its center.

Other species of reptiles and amphibians collected in this area were: *Haldea v. valeriae, Diadophis p. edwardsi, Opheodrys v. vernalis, Elaphe o. obsoleta, Lampropeltis triangulum, Natrix s. sipedon, Storeria o. occipitomaculata, Thamnophis o. ordinatus, Crotalus h. horridus*, and *Hemidactylium scutatum.*

The writers are indebted to Romeo Mansueti, biologist, Maryland Department of Research and Education, Solomons, Maryland; Mr. John Cooper and Joseph Gentile, Natural History Society of Maryland; and especially to Mr. James A. Fowler, Director of Education, The Academy of Natural Sciences of Philadelphia.—LEO LEMAY AND ANTHONY G. MARSIGLIA, *Natural History Society of Maryland, 2101 Bolton Street, Baltimore 17, Maryland.*

THE BELLTOAD, *ASCAPHUS TRUEI*, IN MENDOCINO COUNTY, CALIFORNIA.—A single individual of *Ascaphus truei* was collected on June 20, 1951, at Russian Gulch State Park, ten miles by road south of Fort Bragg, Mendocino County, California. The specimen appears to be an immature animal, its head-and-body length being 22.5 mm. including a short cloacal appendage 1 mm. long. Identification of the specimen has been confirmed by Drs. Tracy I. Storer and Robert C. Stebbins.

The toad was found in a small stream 200 yards upstream from the end of the road leading up canyon from the public campground at the mouth of Russian Gulch. The site is about 1½ miles airline from the seacoast. The canyon in this region is steep walled, damp, and heavily forested with a mixture of redwoods and Douglas fir. The understory is principally of ferns with a few grasses intermixed. The small stream is 3 to 6 feet wide and alternates in character between moderately flowing sections and small quiet pools with sand bars and undercut banks. It was on the edge of one of these pools that the toad was caught. No other individuals were seen. No water temperatures were taken, but the following records for the camp area appear in my notes: "dripping fog, all day; temperatures three feet off ground, 9:30 AM, P.S.T., 14° C.; 1:15 PM, 14° C.; 5:40 PM, 13¼° C. Relative humidities for the same periods were: 88.5%, 80.5%, 84.0%."

Previously, the southernmost record of *Ascaphus truei* was in southern Humboldt County, California. George S. Myers (1931, COPEIA (2): 56–57) found the species in a small stream along U. S. Highway 101 one-half mile north of the junction with the road to Holmes. Robert C. Stebbins (1952, *Amphibians of Western North America:* 189) collected specimens 10.6 miles west of Dyerville (by road to Honeydew), Humboldt County. The present record for central Mendocino County, therefore, extends its range approximately 70 miles to the south. Since streams similar in character to that in Russian Gulch occur in the redwood forest to the south as well as to the north, it is not unlikely that the limit for this species lies even farther to the south, perhaps even in the coastal portion of central Sonoma County.

The specimen, on which the range extension is based, is now in the collection of the Division of Zoology, University of California at Davis.—GEORGE W. SALT, *Division of Zoology, University of California, Davis, California.*

NEW RECORDS OF *RANA VIRGATIPES* AND *RANA GRYLIO* IN GEORGIA AND SOUTH CAROLINA.—Although *Rana grylio* is often called a bullfrog, its relationship evidently lies with *R. virgatipes*, not with *R. catesbeiana*. *R. virgatipes* and *R. grylio* are remarkably similar in general appearance, and many young *grylio* can scarcely be distinguished from adult *virgatipes* except by the greater extent of webbing in the former. The two species are mainly allopatric, *virgatipes* ranging from New Jersey to the Carolinas, *grylio* from Georgia and Florida westward to Texas.

So far as I am aware, only two previously published records suggest some range overlap for these forms. Wright (1923, COPEIA 115: 34) found *Rana virgatipes* in Okefinokee Swamp, Georgia; and Neill (1947, COPEIA (3): 206) reported *R. grylio* in lower South Carolina. Further studies in the area of overlap are obviously to be desired.

Robert L. Humphries first called my attention to the occurrence of *Rana virgatipes* in the Upper Coastal Plain of Georgia. He heard the characteristic call of this species coming from a boggy pond in Screven County, roughly 2 miles southwest of the point where U. S. Highway No. 301 crosses the Savannah River. After noting the habitat here, I was able to find the species at several other localities in Screven County; at Big Duke's Pond near Rogers, Jenkins County; and near DeBruce, Richmond County, Georgia.

The form was also found just south of the junction of U. S. Highway No. 301 and State Highway No. 37, in Allendale County, South Carolina. Apparently the only other South Carolina record is that of Chamberlain (1939, Charleston Mus. Leaflet 12: 34), who mentions a specimen from Leesville, Lexington County. Gee (1936, South Carolina Vertebrate Fauna: unpaged) includes this species in the South Carolina list, evidently following the 3rd edition of Stejneger and Barbour's North American checklist.

In Screven and Jenkins counties, Georgia, and in Allendale County, South Carolina, these frogs occupied ponds overgrown with tall grasses. The plants, nearly head-high in places, sprang from a foot or more of muck and another foot of water; and where they were clustered thickest, with scarcely an inch between any two stems, there *Rana virgatipes* would be found. In the rays of a head lamp the frogs were very hard to see, their yellowish stripes looking remarkably like the grass stems and leaf blades. They took alarm readily, and would dive to the bottom at the slightest provocation.

Large choruses were never encountered. Usually three to six males would voice their hammering calls, and then no sound would be heard for 10 or 15 minutes.

At the Screven, Jenkins, and Allendale County localities, *Rana virgatipes* was accompanied by *R. grylio*, and the latter species was always by far the more abundant. Within the same pond there seemed to be a slight difference in the distribution of the two. *R. grylio* was to be found where the vegetation thinned out a little; indeed, only a small *grylio* could have made its way into the areas of thickly clustered grass stems where *virgatipes* dwelt.

At the Richmond County locality, *Rana virgatipes* was found under somewhat different conditions. Here it was fairly common about a boggy pond strewn with fallen timbers and choked with sphagnum moss. Emergent grasses were present, but were only a foot or two high and not thickly clustered. By day the frogs could be seen sitting on the fallen timbers. When approached, they dove off

into the moss and water. *R. grylio* was not present at this locality, which lies about 7 or 8 miles above the range of that species.

Since the first report of *Rana grylio* in South Carolina (Neill, *loc. cit.*), I have found the form to be common in the southern portion of that state, in Allendale, Hampton, Jasper, Beaufort, and Colleton counties. The range of this species also extends much farther inland in Georgia than previous records indicate. I have taken specimens in Bacon, Brantley, Bryan, Bulloch, Burke, Candler, Charlton, Chatham, Clinch, Effingham, Emanuel, Jenkins, Liberty, Long, Richmond, Screven, Toombs, Ware, and Wayne counties.

Burt (1938, Trans. Kansas Acad. Sci., 41: 353) reports the species at Cass Station, Bartow County, Georgia, but the record must surely be in error. This upland locality lies near the southern tip of the Appalachian Mountains, about 170 miles from the known range of *Rana grylio*.—WILFRED T. NEILL, *Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.*

REMARKS ON SALAMANDER VOICES.—Maslin (1950, Univ. Colorado Studies, Ser. Biol., 1: 29–45) recently discussed salamander voices, and Myers (1951, COPEIA (1): 76) added a few remarks. I wish to present further observations, speculations, and literature references.

Curiously, neither of the above authors mentioned *Plethodon g. glutinosus*, probably the most vocal plethodontid in the eastern United States. Many collectors have heard this salamander squeak or yelp. On several occasions in Richmond County, Georgia, I heard slimy salamanders voice one or two yelping cries when grasped. Mansueti (1941, COPEIA (4): 266) reported a Maryland specimen that squeaked ten times.

The Florida slimy salamander, *Plethodon glutinosus grobmani*, also squeaks occasionally. I collected 213 of these animals and heard not a sound; the 214th squeaked twice, so loudly as to be audible to a collecting companion who was standing about ten feet away. *Plethodon glutinosus* not only squeaks but also makes a popping noise. This has been described by Harper (1930, COPEIA (4): 153).

Cope (1889, *The Batrachia of North America:* 221) says that "the species of *Desmognathus* (possess) a chirrup or whistle." Probably he had in mind *D. f. fuscus*, which sometimes voices a yelp. I have heard this cry on perhaps a dozen different occasions. In Richmond County, Georgia, I picked up a dusky salamander, and it immediately began to squeak and writhe. Its actions so startled me that I dropped it. It fell a few inches to the surface of a rock, where it squeaked about eight times more. Each time it voiced a cry, it "humped up" in the middle. This observation was of considerable interest, for it demonstrated that sound production in this individual was voluntary and did not result simply from the pressure of the collector's fingers. The "humping" might have been a defense posture intended to disconcert a would-be predator. It is not surprising that such behavior has been infrequently reported. Some creatures are known to defend themselves against small enemies but not against large ones. For example, Noble and Mason (1933, American Mus. Nov., 619: 1–29) found that brooding skinks vigorously defended their nests against mice, lizards, and snakes but not against man. A comparable situation might exist with the dusky salamander.

On four or five occasions, I grabbed for a dusky salamander that was wriggling through short grass. As I tried to pluck the salamander out, I also caught hold of several grass blades, the sharp edges of which cut into the little creature. The salamander then squeaked once or twice. This suggests that one stimulus for yelping might be the bite of some sharp-toothed predator. Such behavior would not be without parallel. Many ranid frogs will not voice their "distress call" when held in the hand, but will cry loudly when pressed with a sharp-edged or sharp-pointed object; and certain toads will not release their toxic glandular secretions except under the stress of both danger and pain (Kellogg, 1932, U. S. Nat. Mus. Bull., 160: 37).

The southern dusky salamander, *Desmognathus fuscus auriculatus*, will squeak like its congener. *Pseudotriton ruber vioscai*, when handled roughly, will sometimes yelp once or twice. *Aneides aeneus* occasionally voices a squeak, or even a series of squeaks in rapid succession. *Pseudobranchus striatus axanthus* and *P. s. lustricolus* can often be made to yelp by pinching them with forceps. On several occasions I had been watching a *Pseudobranchus* closely just as it yelped; the mouth of this salamander opens as the sound is emitted. Carr (1940, Univ. Florida Pub., Biol. Sci. Ser., 3: 52) has described the voice of this species and of *Siren lacertina*.

Maslin (*loc. cit.*) describes certain salamanders as making "kissing" sounds. Such sounds are very frequently produced by *Diemyctylus v. viridescens*, *D. v. louisianensis*, and *D. perstriatus*, when suddenly removed from the water. Figuier (1869, Reptiles and Birds: 34) states that European newts "give utterance to a very peculiar noise." *Triturus cristatus* is apparently the form he had in mind.

O. P. Hay (1889, American Nat., 23: 612) presents some interesting remarks about the voice of "*Amblystoma microstomum*" (*i.e., Ambystoma texanum*). He states, "I have heard *A. microstomum* make a variety of sounds. One is a low piping sound uttered just as the animal comes to the surface and emits air from its lungs. It may be heard at a distance of at least three or four feet. It may not be

produced voluntarily. Sometimes the animal will poke its head out of the water and make a low clucking sound, accompanying it with a sudden movement of the throat. It also often produces a grating noise, as if by grinding its teeth together. It may be made to produce this noise by teasing it."

In the rural areas of Georgia, salamanders are called "mud-puppies" or "puppydogs"; they are popularly thought to bark. These inoffensive animals are greatly feared by many local residents; I have often been warned by a very serious rustic that "if'n a mud-puppy barks three times at you, you'll die 'fore sundown."—WILFRED T. NEILL, *Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.*

BURROWING HABITS OF *HYLA GRATIOSA*.—Insufficient attention has been given to the fossorial tendencies of the bellfrog, *Hyla gratiosa*. Le Conte (1856, Proc. Acad. Nat. Sci. Philadelphia, 8: 146) found a specimen that had concealed itself in a hole in the sand. Carr (1940, Univ. Florida Pub., Biol. Sci. Ser., 3 (1): 60) dug several examples from sand at a depth of more than 4 feet, and suggested that the form might be subterranean in winter. In my opinion, *H. gratiosa* dwells in holes or burrows throughout most of the year, except for brief excursions into the open for the purpose of breeding or foraging.

For several years I collected about a large pond near Bascom, Screven County, Georgia. The pond supported a growth of dwarf cypress, but practically no other emergent vegetation of any size. On the higher ground bordering the pond were numerous small turkeyoaks. The sandy soil beneath the oaks was thickly overgrown with bunches of wiregrass. After hard summer rains, dozens of *Hyla gratiosa* could be found breeding in the pond, but would disappear with the advent of clear weather. No frog could have dwelt in the relatively shadeless turkeyoaks and dwarf cypresses, where the temperature often exceeded 100° F. for a greater part of each day. I therefore searched elsewhere, and discovered that the bellfrogs were in the sand at the bases of wiregrass clusters, at a distance of about 40 to 80 feet from the pond. Some of the frogs nestled in mere concavities in the sand, while others occupied burrows 2 or 3 inches in depth. The burrows were hard to find; the most effective technique was to probe with the fingers around the base of each wiregrass clump. A few *Pseudacris ornata* were also found while probing for *H. gratiosa*.

Bellfrogs are common in Marion County, Florida, where choruses of 100 or more males are sometimes encountered. Many local farmers have plowed up these frogs and brought them to the Reptile Institute.

On one occasion, in Burke County, Georgia, I collected a southern hognose snake (*Heterodon simus*) that had devoured a *Hyla gratiosa* and a *Pseudacris ornata*. On another occasion, in the same area, I found a southern hognose snake that had recently eaten two adult bellfrogs. Both snakes were taken during periods of hot, dry weather, when *H. gratiosa* was not breeding.

It is not known whether the bellfrog digs its own burrow. It may be significant that the metatarsal tubercle in this form is large and hard, better developed than in the other southeastern species of *Hyla*.

I have caught great numbers of breeding bellfrogs in ponds, and a few on bushes and treetrunks near the water, but have never seen a specimen more than 5 feet off the ground.

Wright (1932, *Life-histories of the frogs of Okefinokee Swamp, Georgia:* 300) states that *Hyla gratiosa* has two different calls, the breeding call (on the recording, *Voices of the Night*, part 2), and a very different barking note given from the trees. I have heard this barking note, coming from the tops of live-oaks in areas where *H. gratiosa* was abundant, but never tracked the call to its source. Presumably the form is arboreal at times. It seems odd, however, that a single species should be both fossorial and arboreal, and should possess two very dissimilar calls. The situation obviously merits further study.—WILFRED T. NEILL, *Research Division, Ross Allen's Reptile Institute, Silver Springs, Florida.*

Ichthyological Notes

EGG COUNTS OF *SALVELINUS MALMA* FROM THE CLARK'S FORK RIVER, MONTANA.—As part of a projected study of the Dolly Varden Char, *Salvelinus malma* (Walbaum), in western Montana, fifty-one breeding adults were trapped by personnel of the State Fish and Game Department from Bull River and Prospect Creek near Thompson Falls, Sanders County. Traps were operated at the mouths of these two streams during the period of August 1 to 8, inclusive, 1950. The fish taken represent migrants from the Clark's Fork River and possibly from as far downstream as Lake

Pend Oreille in Idaho. All of the fish possessed exceptionally deep bodies and were characteristically very fat. No food material was found in any stomach, and furthermore, the contracted condition of the stomachs indicated that some time had passed since the last eating period.

Of the twenty-eight females collected, fifteen were trapped from the mouth of Prospect Creek and the remaining thirteen were taken from the mouth of Bull River. These twenty-eight ranged in size from one pound, ten ounces to eight pounds, twelve ounces. Ages of the fish have not yet been determined, but this information will be included in a later report.

TABLE I

INDIVIDUAL RECORDS OF FECUNDITY FOR 28 *Salvelinus malma* FROM BULL RIVER (BR) AND PROSPECT CREEK (PC)

Fish number	Left ovary count	Right ovary count	Total eggs	Total length in mm.	Weight in lbs. and ounces	Source
28850	724	613	1,337	455	1–10	BR
26650	1,368	1,304	2,672	490	2–4	BR
30250	1,730	1,632	3,362	575	3–0	BR
29150	1,570	1,312	2,882	544	3–1	BR
25250	1,672	1,443	3,115	571	3–14	BR
25450	2,041	2,036	4,077	583	4–4	BR
25850	1,526	2,459	3,985	604	4–5	BR
30050	2,329	1,969	4,298	584	4–12	BR
27650	2,215	2,538	4,753	633	5–2	BR
28550	2,548	2,991	5,539	635	5–7	BR
26750	2,746	2,914	5,660	675	6–4	BR
28950	3,920	3,479	7,399	663	7–6	BR
27150	4,358	4,487	8,845	740	8–12	BR
27050	1,608	1,571	3,179	545	3–2	PC
26850	1,429	1,451	2,880	600	3–10	PC
26450	1,795	1,605	3,400	584	3–14	PC
29250	2,544	2,012	4,556	582	4–2	PC
27450	1,662	2,154	3,816	625	4–7	PC
26950	2,175	2,113	4,288	610	5–1	PC
29050	2,509	2,838	5,347	650	5–8	PC
27550	2,617	2,227	4,844	663	6–1	PC
29950	2,497	3,020	5,517	657	6–2	PC
29350	3,550	3,498	7,048	662	6–7	PC
29850	3,571	3,202	6,773	660	6–8	PC
25950	3,460	3,281	6,741	655	6–11	PC
26350	2,943	2,990	5,933	684	6–13	PC
28750	3,580	4,742	8,322	680	6–14	PC
26550	4,211	3,171	7,382	723	7–4	PC

Actual egg counts were made for each of the twenty-eight fish (Table I). The totals represent the number which could be deposited, inasmuch as there were no intermediate sizes of eggs within the ovaries. The left ovary produced more eggs in seventeen fish, whereas the right ovary produced more in eleven fish. The greatest numerical difference found between the number of eggs produced by the two ovaries was in fish number 26550, in which the left ovary produced 1,040 more eggs than the right. The greatest percentage difference is in specimen number 25850, in which the right ovary produced about 62 percent of the total.

It would be difficult, indeed, to figure average numbers of eggs produced by a species of fish which varies so much in size and in length-weight relationship. This can be illustrated by the two specimens which have the length of 663 millimeters. One fish weighed one pound, five ounces more than the other and produced 2,555 more eggs. However, Table II is a rough attempt to correlate numbers of eggs to an arbitrary size class of one-pound intervals. Because of the great variation and the small number of samples, these figures can be interpreted only as indications. A more accurate and informative method of calculation would be to consider the number of eggs per pound of fish. In the present study, it was found that an average of 962 ± 114 eggs were produced per pound of fish, with a range of 795 to 1,210.

TABLE II

AVERAGE NUMBER OF EGGS PER FISH IN *S. malma* AT ARBITRARY ONE-POUND CLASS INTERVALS

Pound class	Number of specimens	Average number of eggs	Range
1–2	1	1,337	—
2–3	1	2,672	—
3–4	6	3,136	2,880–3,400
4–5	5	4,148	3,816–4,556
5–6	4	4,982	4,288–5,539
6–7	8	6,355	4,844–8,322
7–8	2	7,396	7,382–7,399
8–9	1	8,845	—

The author is indebted to Robert L. Freer and Donald Dunham, who acted as research assistants. Funds and aid were supplied by both the Montana State Fish and Game Commission and the Research Council of Montana State University.—
ROYAL BRUCE BRUNSON, *Montana State University, Missoula, Montana.*

SPAWNING OF THE DOLLY VARDEN, *SALVELINUS MALMA*, IN TWIN CREEK, IDAHO.—It was our good fortune while making surveys of salmonid spawning grounds in the basin of the Clark Fork River above Lake Pend Oreille, Idaho, on November 8, 1951, to watch a beautiful, large pair of Dolly Varden charr, *Salvelinus malma* (Walbaum), go through their spawning paces. Search of the literature indicates that little is known regarding the breeding behavior of these fish, though Belding (1934, Trans. Amer. Fish. Soc., 64: 211–16) described the natural spawning of Atlantic salmon (*Salmo salar*), Needham and Taft

(1934, *Ibid.*, 332–38) that of the steelhead (*Salmo gairdneri*), Schultz (1935, Jour. Pan.-Pac. Res. Inst., 10: 67–77) the little redfish, (*Oncorhynchus nerka*), and Smith (1941, Jour. Wildlife Mgt., 5: 461–71) that of the eastern brook (*Salvelinus fontinalis*) and cutthroat trout (*Salmo clarki henshawi*).

The observations reported here were made in Twin Creek, a small tributary of the Clark Fork River entering from the south approximately seven miles above Lake Pend Oreille in Bonner County, Idaho, some four miles from the Montana-Idaho border. The Clark Fork, Snake, and Kootenai rivers form the three major tributaries of the upper Columbia River.

Twin Creek rises in the Cabinet Mountains and flows some four miles before entering the Clark Fork River. It is small, averaging about 25 feet in width. When our observations were made its flow was approximately seven cubic feet of water per second. Its upper reaches are precipitous, and not until it meanders through meadow and pasture lands below are suitable spawning grounds found.

The nest we observed was built in a gravel riffle about 50 yards below the point where a Northern Pacific Railroad trestle crosses the stream and about 200 yards above the point where Twin Creek flows into the Clark Fork River. Here the stream has a gentle gradient, meanders over short riffles, and is surrounded on both sides by pasture. The general level of the stream bed has been eroded away so that it is some 10 to 15 feet below the bordering pasture lands. A short distance below, it flows into areas of muddy banks and bottom just before it enters the Clark Fork.

A beaver dam had been built across the upstream side of the railroad culvert to a height of about three feet, and apparently the Dolly Vardens had been blocked from passing through the culvert by this dam and had dropped back downstream to spawn. The nest was located just above and to one side of a beaver dam, close to the east bank of the creek. This dam was only about a foot high and evidently its construction had just been started, for the water had not backed up over the gravel in the nest area far enough to obliterate riffle conditions. Some thirty feet above the nest was a deep pool affording fine shelter under stumps and submerged logs. We were able to move slowly to within about seven feet of the nest without disturbing the fish. It was from this point that our observations were made. The depth of the water over the nest was six to seven inches, and the nest diameter was approximately 30 inches.

The female was plump and well formed and appeared to be 20 to 22 inches long and may have weighed as much as five pounds. She was dull green on the back, fading to lighter below. Because of the poor light and weather conditions it was impossible to discern any spots on her sides. The ventrals and anal fin were not edged anteriorly with white as they were in the male. The male had a long, pointed snout and was estimated to be 24 to 26 inches long and to weigh around six pounds. His anal and ventral fins flashed the brilliant red color that contrasts sharply with the wide white anterior margins so characteristic of male charrs in spawning garb. Their coloration seemed in general agreement with the description given by DeLacy and Morton (1942, Trans. Amer. Fish. Soc., 72: 79–91) and others, though the distance from which we were forced to observe the fish did not permit clear detection of color details.

When we first arrived, the male was trying to stimulate the female to spawn. At intervals of about three or four seconds he slid up against her side, quivering vigorously from head to tail. We could easily see the great lateral muscles vibrate and when he swerved at the proper angle to reflect light, the bright bronze color on his sides was clearly evident. Even the lower jaw vibrated as the action was quite vigorous. In addition he swam at times over the tail of the female, coming to rest along her side, after which the quivering motion was repeated.

Nest-digging by the female was seen only once, and it was a rather weak effort compared to the redd-making of steelhead and other trout. Evidently digging of the nest had been largely completed. Flat on her side, working her tail vigorously up and down, she moved bottom materials to form a depression in the gravel. This is the usual method of digging by female salmonids. We had a fine view of the shining, white color on the belly when she was in this position.

In spawning both fish were centered over the nest with their vents in the deepest portion. Their heads were separated by about six inches and formed an angle of about 25 degrees to each other. Both fish opened their mouths wide, arched their backs, and quivered as the sex products were forced out. The white lining of their mouths was clearly visible and wavelets formed by the quivering ruffled the smooth water surface. The first spawning act lasted approximately two seconds. After an interval of about ten seconds the pair spawned again, for a period of four to five seconds. Milt was seen to cloud the water in both spawnings, though no eggs could be seen because of the angle from which the observations were being made. After the second spawning act the female immediately began a curious weaving motion over the nest, keeping her head upstream. She weaved slowly back and forth, working the caudal, anal, and ventral fins into the gravel, moving clean stones and pebbles against or across the current and over the eggs in the bottom of the nest. As reported

by Smith (*op. cit.*), eastern brook trout in covering the eggs use this same method, which is entirely different from the procedure employed by cutthroat and rainbow trouts, including steelhead, and by salmon (*Oncorhynchus*). Those species cover their eggs by digging upstream a foot or so above the nest so that the disturbed gravel is washed over the eggs by the current. As described by Smith, a female eastern brook "started sweeping pebbles forward with her anal fin. The anal fin was held down against the stones and then by a twisting movement of the body and a slight push with the tail it was scraped, point foremost diagonally across and upstream. The movement was a sweeping one and the fin did not actually dig into the gravel. Many times not a single pebble was disturbed by the movement but as the female rhythmically swept the gravel diagonally from first one side and then the other, she gradually moved pebbles forward and over the eggs. She did not disturb any of the eggs while doing this." It is evident therefore that the spawning behavior of the Dolly Varden is very similar to that of the eastern brook trout. In the light of Smith's description, we judge that the female Dolly Varden we observed moved much faster than eastern brook trout do in the process of covering the eggs. The movement of the stones seemed to be effected more by the current and less by actual contact with the fins. The gentle, weaving movement seemed to provide for protection of the eggs deposited a few moments earlier.

While the female covered the eggs, the male moved to a point just below and to the right of the nest, in shallow water above the beaver dam. He came back over the nest once during this process and was promptly nudged out of the way and off the nest by the female, whereupon he dropped back again to his former position, some fifteen feet from the nest, and then rested motionless in the water. The female continued her weaving movements over the nest for about ten minutes, until frightened away as we moved up to make closer observations of the nest itself since the light was rapidly failing. The male darted away first to the deep shelter in the pool above the nest, but the female left only when we had approached very close to the nest. As we were leaving we noted that both fish were dropping back into the nest area.

The air temperature was 48°F. and the water 41°F. at 4:00 P.M. We located the fish about 3:30 P.M. and watched them until about 4:45 P.M.

When he returned to the nest the next day, the junior author found it complete. He wrote, "Both tenants had left the premises but I have never seen a neater house. The entire nest had been filled in with small pebbles ranging from matchhead size to rocks as large as chicken eggs. The nest was not only filled in but was mounded up, tapering from the sides to a height of about three inches in the center. Apparently the fish had practically completed spawning when we saw them yesterday for the complete transition took place in less than eighteen hours. I searched the stream down from the large beaver dam at the railroad trestle to the mouth but could not find either of them."

We wish to thank Dr. Carl L. Hubbs, Mr. W. Markham Morton, and Dr. Allan DeLacy for reading this manuscript critically and offering suggestions for its improvement.—PAUL R. NEEDHAM, *Department of Zoology, University of California, Berkeley, California,* AND TIM M. VAUGHAN, *Idaho Fish and Game Department, Sand Point, Idaho.*

GREENLAND COD (*GADUS OGAC*) IN MIRAMICHI BAY, NEW BRUNSWICK.—Until Vladykov (1945, Naturaliste Canadien, 73 (1 et 2): 28–31) reported finding it in fair numbers from Belle Isle Strait westward along the north shore of the Gulf of St. Lawrence, there were no other records of *Gadus ogac* Richardson in the Gulf. However, in late March, 1949, two specimens were taken off Portage Island just inside Miramichi Bay in eastern New Brunswick, about 200 miles still farther south than the places where this species was found by Vladykov.

To the local French fishermen these fish are known by the name of "Pilot" and to the English-speaking fishermen as "Rock Cod." They are reported to occur as far up Miramichi Bay as Oak Point; that is, almost to the head of the Bay. Reports as to their abundance vary, seemingly according to where the smelt fishermen operate during the winter, some claiming to catch one to five almost every winter, while others see them only every four or five years.

During the summer they are said to be taken occasionally in lobster pots, while a few fishermen claim to have found them so abundant on certain cod-jigging grounds that they were forced to shift their operations for lack of larger cod. Reports as to their size indicate that they range from 14 to 18 inches, rarely larger. Some fishermen claim they are no good for food (at least in winter) as the flesh is greyish in colour and becomes very soft, falling apart when cooked unless cooked in the round.

The measurements (in mm.) and counts of our two specimens, 352 mm. and 398 mm., respectively, in standard length, are as follows: head length: 113, 118; eye: 15, 19; snout: 39, 42; length of upper jaw: 51, 53; interorbital space: 31, 32; barbel length: 10 (mutilated), 21; pectoral length: 66, 68; caudal peduncle depth: 20, 20; rays in first dorsal: 14, 13; second dorsal: 15, 16; third dorsal: 13, mutilated; rays in first anal: 17, 19; second anal: 15, 18. The peritoneum is black in both specimens.

One of our two specimens was sent to the Royal Ontario Museum of Zoology, Toronto, where Dr. W. B. Scott, Curator, Division of Ichthyology and Herpetology, verified it, and it is now in their collections under catalogue number 13,994.—R. A. McKenzie, *Atlantic Biological Station, St. Andrews, N. B., Canada.*

A NEW RECORD OF THE POINTED-TAILED OCEAN SUNFISH, *MASTURUS LANCEOLATUS*, FROM NORTH CAROLINA.—The Pointed-tailed Ocean Sunfish, *Masturus lanceolatus* (Liénard), has been recorded only four times on the North Carolina coast (Brimley, 1939, Jour. Elisha Mitchell Sci. Soc. 55 (2): 295–303) prior to the capture of the fish described below. These records are as follows: Cape Lookout, May 15, 1904; Brown's Inlet, Onslow County, Nov. 1, 1937; Masonboro Inlet, New Hanover County, Dec. 20, 1937; Pamlico Sound, 1 mile west of New Inlet, Dec. 22, 1937. The new specimen was taken 1 mile south of Kure's Beach, New Hanover County. Brimley also listed four specimens of *Mola mola* from North Carolina, making a total of only eight of these giant sunfishes heretofore known from the state.

During the afternoon of January 9, 1949, a group of fishermen from Kure's Beach saw a large fish floundering in the wash of the surf, pulled it ashore with a winch, and put it on display at the local icehouse. One of us (J. B. F.) identified it as *Masturus lanceolatus* and took measurements. The weight, 351 lbs., was obtained on the ice scales before the fish was dead. The following measurements are in inches: length (tip of snout to tip of caudal) 65½; greatest body depth 34; greatest body width 15; tip of dorsal to tip of anal 75; greatest eye diameter 2¼; tip of tail to edge of tail muscles 14; depth of tail at base 28; width of open mouth 5; width of gill opening 4½; interorbital width 8½; length of pectoral 7; dorsal fin 12 x 19; anal fin 11 x 22. The protruding tip of the tail was short and rounded, not long and pointed, but Gudger (1937, Proc. Zool. Soc. London, Ser. A, 107: 353–96) has shown that such abbreviation, due to mutilation, is common to most specimens figured and described. The number of pectoral fin rays was 7, whereas Brimley (1939) and Gudger (1937) gave counts of 9 or 10.

The color of the fresh fish was as follows: belly and sides silvery gray, merging into the bluish-black of the back. Caudal and dorsal fins darker than the back, pectorals lighter, and anal fin a darker gray than the sides and belly. Numerous silver spots, varying from the size of a dime to that of a quarter, scattered at random over sides of body and caudal fin.

An interesting aspect of the capture of this fish is the manner in which it was disabled. The caudal fin of a small fish protruded about half an inch from the gill filaments in the right gill opening. This fish was wedged tightly between two of the gill arches, and was removed intact with a great deal of difficulty; it was a shark-sucker, *Remora remora* (Linnaeus), 10 inches long and 3½ inches in circumference. Since the *Remora* wedged the gill arches on one side tightly enough so that they could not function and thereby partially blocked the throat cavity of the sunfish, the disruption of its breathing mechanism was evidently the primary cause of its disability and capture. It would have been impossible for the *Remora* to come back out of the gill opening because the dorsal and pelvic fins were caught by the gill rakers of the sunfish.

It is not unusual for small shark-suckers to be found on the gills of large sharks and other fishes. A small specimen of another sucking-fish, *Rhombochirus osteochir* (Cuvier), has been found in the gills of *Mola mola* (Gudger, 1926, Amer. Mus. Novitates 234: 1–26). Gudger (1937) recorded several specimens of *Masturus* caught with sucking-fish in the gill cavities, in the buccal cavity, or on the surface of the body. The present instance shows that the habit of using the gills as a place of refuge in the case of small echeneids may be carried into later stages on occasion, and that the available space may not be adequate.—John B. Funderburg and Theodore H. Eaton, Jr., *East Carolina College, Greenville, North Carolina.*

ESTABLISHMENT OF WHITE PERCH, *MORONE AMERICANA*, IN CENTRAL NEW YORK.—White perch, *Morone americana* (Gmelin), have been taken in considerable numbers during the past three or four years at Cross Lake and adjacent parts of Seneca River as far east as Baldwinsville. This lake lies mostly in the western portion of Onondaga County, but a small portion extends into Cayuga County. The outlet of the lake is Seneca River, but its water eventually reaches the Atlantic Ocean via Oswego River, Lake Ontario and the St. Lawrence River. The white perch now appears to be well established, definitely on the increase, and extending its known range. Its appearance in Cross Lake is a dark mystery, although one might well assume that it was introduced, as otherwise it would not be so localized.

So far as is known this is the first record of its occurrence in the State this far inland. Normally a saltwater species, it has been successfully introduced in freshwater lakes and ponds of New England, where it reproduces and sometimes becomes extremely abundant. There are no published records of its occurrence in the Great Lakes and their tributaries, the Finger Lakes or Oneida Lake.

Local anglers, in general, have been rather perplexed as to the identity of the species. Superficially it somewhat resembles the silver bass, *Lepibema*

chrysops (Rafinesque), which is rather common in this area, and some anglers assumed that it was that species, but lacking the characteristic longitudinal stripes. In light of this it is quite likely that occasional catches were made before the species became sufficiently abundant to attract general attention. The writer was unaware of its presence in these waters until April 27, 1950, when a local angler asked him to examine a fish, representative of the "unknown" that were being caught frequently at that time. On October 20, 1950, sixteen fish 3¼ inches to 3½ inches total length were collected along shore with minnow seines. Although the lake was very rough and seining difficult nearly every haul yielded white perch to almost full exclusion of other species. The species takes the hook freely and at times represents the major portion of the angler's catch.

A local resident at Cross Lake mentioned that white perch had been introduced for the purpose of "eliminating" the abundant population of carp. The manner in which this was supposed to be accomplished or further details on the project could not be obtained, and consequently the authenticity of the statement is questionable.

While there is some variation in size, most of the fish taken on hook and line were slightly over 6 inches in length, representing mostly five to six years of growth. The dorsal fins were slightly conjoined at the base by a membrane, their formula IX, I, 12. The first anal spine was 8 mm. long, the second 21 mm., and the third 23.5 mm. The anal fin formula was III, 9. The longest dorsal ray was 27 mm. long, the longest pectoral 35 mm. Scales 8-50-12. Other measurements were as follows: standard length 158 mm., snout length 15 mm., head 52 mm., eye 11 mm., body depth 56 mm.; the gill rakers numbered 4 + 14 and were as long as the fringes. Scales on dorsal side of head extended as far forward as the nostrils. The base of the tongue was toothless. Color olivaceous on dorsal side, silvery on belly, with very faint longitudinal silvery stripes along the sides. Dorsal, caudal and anal fins tipped with black.

The small white perch taken in October were very fat and at the time of capture had been feeding almost exclusively on midge larvae. There were no annuli on the scales examined, indicating that the fish were less than a year old. They had attained excellent growth for such a brief existence.

The rapid rate of reproduction and subsequent development eventually should result in vast changes in the associated fish fauna and the over-all ecology and economy of the environments that the white perch are appropriating. In time, some of the native fishes may not be capable of competing with the white perch for the available food, shelter or breeding sites. Each succeeding year shows greater numbers of young fish, which were particularly abundant during the summer of 1951.

Cross Lake supports a varied and rather unusual mixture of fish species, including the alewife (*Pomolobus pseudoharengus*), American smelt (*Osmerus mordax*), freshwater drum (*Aplodinotus grunniens*), longnose gar (*Lepisosteus osseus*), gizzard shad (*Dorosoma cepedianum*), lake sturgeon (*Acipenser fulvescens*), bluegill (*Lepomis macrochirus*), and carp (*Cyprinus carpio*). The most popular species with anglers are northern pike (*Esox lucius*), yellow walleye (*Stizostedion v. vitreum*) and the black basses (*Micropterus dolomieui* and *M. salmoides*). Carp are extremely abundant and are being controlled by commercial netting.—W. A. DENCE, *State University of New York, College of Forestry, Syracuse, New York.*

ON THE DISTRIBUTION AND HABITS OF THE WATTLED EEL-POUT, *LYCODES PALEARIS*.—The recent note by B. W. Halstead entitled "The Capture of a wattled eel-pout, *Lycodes palearis* Gilbert, from Fidalgo Island, Washington, and the distributional record of the species" (COPEIA, 1950 (4):317) has prompted us to offer the following comments relative to the status of this fish in Puget Sound and Alaskan waters. Halstead's review of the Washington literature is incomplete, at least to the extent of failing to mention the listing of Schultz and DeLacy (Mid-Pacific Magazine, April–June 1936: 142) in which original records for the San Juan Island region are indicated symbolically. These are substantiated by specimens catalogued in the collection of fishes of the University of Washington School of Fisheries as follows: No. 1208, 3 specimens from near Olga, Orcas Island, by V. Shelford and class, July 18, 1930; No. 5362, 2 specimens from Point Roberts Reef, Georgia Strait, by F. Cleaver, June 4, 1943; No. 5639, 2 specimens from Boundary Bay, 6 miles south of Point Roberts, by G. Holland, April 25, 1949; and Nos. 6228, 6857 and 6997 discussed below. Halstead also implies that the species is known from Alaska waters only on the basis of the type collection of three specimens taken at depths of 36 and 46 fathoms in Bristol Bay in 1890 by the ALBATROSS. The following catalogue entries of Alaskan specimens in the University of Washington collection will serve to supplement this: No. 978, 1 specimen from Zaikof Bay by the International Fisheries Commission, Nov. 20, 1928; No. 1673, 7 specimens from Wrangell by F. J. Gunderson, December 1, 1931; No. 2057, 1 specimen from Yakutat Bay by J. L. Kask, June 21, 1932; No. 2602, 1 specimen from Petersburg by Dorothy Scott, September 1932; No. 3042, 2 specimens from Petersburg, Thomas Bay, by C. L. Anderson, August 3, 1920; No. 3915, 3 specimens from Orca Inlet by Paul Thompson, April 2, 1935; No. 5579, 1 specimen from

Bering Sea, 57° 30′ N, 167° 30′ W, by the trawler DEEP SEA, June 26, 1947; No. 6860, 1 specimen from Tenakee Inlet, Nov. 5, 1950; and 7 taken by the trawler DEEP SEA in drags 4, 17, 18, 47, 48 and 51 (*fide* Hildebrand MS on file with U. S. Fish and Wildlife Service, Seattle) in Bering Sea in the summer of 1949. For records of the itinerary and sampling operations of the DEEP SEA, see U. S. Fish and Wildlife Service Fishery Leaflet 369, 1950, especially Table 5 and Fig. 6. The DEEP SEA specimens are presently included in the School of Fisheries collection with the following designations: No. 6917, Norton Sound; No. 6919, St. Matthew Island (60° 44′ N, 172° 34′ W) in 29–30 fathoms (Drag #4); No. 6921, Norton Sound; No. 6927, southeastern Bering Sea (56° 17′ N, 164° 53′ W) in 51 fathoms (Drag #51). The Norton Sound stations (drags 17 & 18: 63° 50′ N, 165° 02′ W; and 63° 53′ N, 164° 08′ W, respectively) lie about 450 nautical miles north of the (type) locality cited by Halstead as the northernmost station for the species. Some of the foregoing collections, plus a number by the ALBATROSS and others from as far north as Latitude 60° N in Bering Sea and depths as great as 100 fathoms, are also represented in the collections of the U. S. National Museum according to Dr. L. P. Schultz and R. Kanazawa (letter of May 7, 1951).

On April 13, 1951, beginning at 13:37 PST, the School of Fisheries M. V. ONCORHYNCHUS trawled for ten minutes at depths ranging between 136 and 155 fathoms off Point Jefferson in central Puget Sound opposite Seattle (47° 45′ N, 122° 25′ W., Haul No. 5112D). The haul contained a variety of specimens including an adult female *Lycodes palearis* 307 mm. in total length, now preserved in the School of Fisheries collection as No. 6228. The depth of this capture is of interest, far exceeding those previously recorded for this species (6 to 100 fathoms). A small range extension is also represented, the site of capture being approximately 54 air miles (statute) south of Ship Harbor, Fidalgo Island, the southernmost previously known locality. Another specimen (UWSF No. 6857, immature female 269 mm. long) was trawled by the ONCORHYNCHUS in Hood Canal off Thornedike Bay on December 21, 1949 in 22 to 28 fathoms (47° 48′ N, 122° 42′ W). The general rarity of *L. palearis* in Washington waters may be estimated by the fact that these specimens are the only ones detected in the course of a sampling program carried on primarily in Puget Sound but occasionally also in Washington Sound and off the Olympic sea coast in the past three years, involving to date some 98 beach seinings and 409 trawl hauls at all depths down to 320 fathoms. By contrast, many hundreds of the eelpout, *Lycodopsis pacificus* (Collett), have been taken in the course of this program.

No mention of the food and other life habits of this species is made in the available literature. The Seattle specimen contained the more or less fragmented shells of over a dozen *Yoldia ensifera* Dall (species?) 12 to 20 mm. in length, plus a carapace and a sub-entire specimen of a small shrimp (*Crago* sp.) 40 to 45 mm. in body length. Additional insight into the food habits of this species has been gained from experience with captive specimens. Several years ago, one of us obtained from Mr. Neil Hedrick, curator of the marine aquarium at Bellingham, Washington, two of several specimens of *Lycodes palearis* which he had obtained from trawlers operating in the Bellingham Bay-Point Roberts area, and which he had successfully acclimated to the tanks. These were maintained for many months in the municipal aquarium at Tacoma where they occupied a 50-gallon tank of running seawater of approximate isothermality with Puget Sound at that point (usual annual range 45° to 55°F.). Here they remained for the most part immobile on the sandy bottom, often side by side in a narrow space between a rock and the wall of the tank. They were sluggish feeders, accepting chunks of herring which were left on the bottom of the tank overnight, or snapping up pieces impaled on a slender stick and touched gently to the fish's snout. Chunks of clam and shrimp and salmon liver were also accepted.

The male eventually developed necrotic areas on the skin, became emaciated, and died in November 1948 (length preserved, 352 mm.). Shortly afterward, the female became so greatly swollen with eggs that "egg-bind" was feared, and she was relieved of the major part of her roe by manipulation and vacuum tube on January 1, 1949. The eggs thus obtained were noted at the time as being less than fully ripe because of adhering bloody "follicular remnants", but were large (6–7 mm.), elliptical and more or less flattened to subspherical, and clear pale amber in color. The preserved eggs show a prominent disk of aggregated fat globules at the apex of each egg. About three-fourths of the total complement were taken artificially, the remaining quarter being spawned by the fish during the ensuing night. The latter eggs lay singly or in small clusters on the sand bottom of the tank the next morning. Marked water-hardening did not occur, i.e., a turgid chorion and noticeable pervitelline space did not develop. Counts were not made, and the female died the following June of a condition similar to that of the male eight months earlier (length preserved, 292 mm.). Both specimens are preserved as Cat. No. 6997 in the University of Washington School of Fisheries collection.

A question has been raised in Dr. Schultz's letter (cited above) as to the conspecificity of U. S. National Museum specimens from Washington state with those from more northern waters. With the cooperation of Mr. William Bayliff, who this year is

beginning a study of Pacific Coast zoarcids, we ha ve satisfied ourselves on the basis of color and certain meristic characters, that our specimens are of the species *L. palearis* as presently understood. The question of racial identity will be dealt with more fully in Bayliff's study.—J. W. SLIPP AND A. C. DELACY, *School of Fisheries, University of Washington, Seattle 5, Washington.*

A NEW NAME FOR THE PERUVIAN PARROTFISH, *SCARUS DUBIUS* HILDEBRAND PREOCCUPIED BY *S. DUBIUS* BENNETT.—In his report on Peruvian fishes, Hildebrand (1946, U. S. Nat. Mus., Bull. 189: 351–54) described a new parrotfish, *Scarus dubius*. This name is preoccupied by *Scarus dubius* Bennett (1828, Zool. Jour., London, 4: 37–38) collected in the Hawaiian Islands. I herewith propose **Scarus hildebrandi,** a new name, to replace *S. dubius* Hildebrand.—ROBERT H. KANAZAWA, *Division of Fishes, U. S. National Museum, Washington 25, D. C.*

AN OBSERVATION OF "FLIGHT" IN THE POMPANO.—While returning from a collecting trip to the Florida Keys about September 1, 1949, the writer witnessed a rather remarkable "flight" behavior in an unidentified species of pompano which on gross appearance was thought to be *Trachinotus carolinus* (Linnaeus). The fish was observed from a small boat operated by Capt. W. B. Gray of Miami Beach, proceeding at about six knots in the direction of Miami, roughly midway between Rickenbacker and MacArthur causeways in Biscayne Bay.

Suddenly a white object approximately a foot in length sailed nearly the full length of the boat and disappeared into the water just astern. At first this object was thought to be a paper plate blown by the wind, but just before it vanished it was identified as a pompano. A few seconds later this performance was repeated by a second pompano of comparable size and the "flight" technique of this specimen was observed more closely. The fish was sailing on its side with the anterior end slightly elevated, which, considering the compressed body form and similarity between the dorsal and ventral profiles of this fish, seemed a logical position for it to assume in order to utilize air-support to the best advantage. The height of the course described appeared to be about two feet above the surface of the water. Capt. Gray stated that he has observed this behavior on previous occasions.—CRAIG PHILLIPS, *Marine Laboratory, University of Miami, Coral Gables, Florida.*

RECORDS OF THE WESTERN LAKE CHUBSUCKER, *ERIMYZON SUCETTA KENNERLEYI*, FROM ONTARIO, CANADA.—In the course of conducting field studies on Lake Erie fishes under the sponsorship of the Research Council of Ontario, specimens of *Erimyzon sucetta kennerleyi* (Girard) were captured in waters adjacent to Lake Erie. This species does not appear to have been recorded previously from Ontario waters. The first collection was made by the author and G. H. Lawler on August 16, 1949, using a 30-foot seine in large ponds on the eastern side of Point Pelee. The ponds are separated from Lake Erie by a strip of sand 25 to 30 yards wide but are accessible from the open lake, for at least part of the year, by one or two open channels. The seven young, immature specimens captured were conspicuously marked with a distinct black lateral band and had a decidedly reddish caudal fin. In October of the same year Dr. W. M. Sprules caught two mature females while seining in Lake St. Clair. Still a third record was provided in 1951 from a collection of fishes made in the ponds on the end of Long Point, Lake Erie, by J. Bruce Falls. This latter collection also consisted of young specimens.

Thus the known distribution of the western lake chubsucker in Ontario is as follows: Ponds on both Long Point and Point Pelee on Lake Erie, and in Lake St. Clair. Although these appear to be the first records for this species in Ontario, Hubbs and Brown (1929, Trans. Roy. Can. Inst., 17: 2) placed this fish on a list of species to be sought for in Ontario. Since the Lake Erie ponds are not easily approached by land, the species may have been living in them for some years undetected by collectors. Access to the ponds by the species may have been gained either during periods of high water and flooding of the ponds, or by the open channels which occasionally exist, or both. Despite extensive seining along the north shore of Lake Erie in recent years, no specimen has been taken, although the species does occur in the southern tributaries of the lake, notably in Ohio.

Following are the locality data, number of specimens in parentheses, ranges in standard lengths, and dorsal ray counts for all specimens mentioned above: Ponds on Point Pelee, Aug. 16, 1949 (7), 27–42 mm., 11 (6) or 12 (1); Lake St. Clair, Oct. 12, 1949 (2), 88–93 mm., 11 (2); ponds on Long Point, July 12, 1951 (5), 28–32 mm., 10 (1) or 11 (4).

The dorsal ray counts are in agreement with those given for the species in the Great Lakes region. All specimens are in the fish collection of the Royal Ontario Museum of Zoology and Palaeontology.—W. B. SCOTT, *Royal Ontario Museum of Zoology and Palaeontology, Toronto 5, Canada.*

A METHOD OF MARKING LARVAL LAMPREYS.—Biological investigations of lamprey populations in central New York have indicated a need for developing a method of marking larvae of the sea lamprey, *Petromyzon marinus* Linnaeus, and the American brook lamprey, *Lampetra lamottei* (Le-

Sueur) Since lamprey larvae live in burrows in the soft sediments of the stream bottom, the use of an external tag is impractical.

The first marking method tried on lamprey larvae of both species mentioned above, held in troughs in the Cornell University Experimental Fish Hatchery, was that of tattooing. A procedure similar to that which Woodbury (1948, COPEIA, (2): 127–28) used on snakes was followed. Although tattoo marks remained visible on the lampreys for as long as 1½ years, they tend to become obscure due to the loss of the dye before the wounds heal, and due to the development of melanophores in the skin which hide the pigment after the wounds heal. Furthermore, since the penetration of the needle is approximately two millimeters, it is not feasible to tattoo lampreys smaller than 100 mm.

Dunn and Coker (1951, COPEIA, (1): 28–31) injected biological stains such as Fast Green, Trypan Blue, and others, intra-muscularly into fishes with a hypodermic syringe. However, mortality was high and the durability of the stains was, for the most part, short. Kask (1936, Science, 83: 435–36) obtained good results when he "tattooed" halibut using Higgins India Ink in a hypodermic syringe. In order to obtain a harmless and a more distinctive mark, a modification of the above injection method was developed. Dyes were prepared consisting of cadmium sulfide (yellow), mercuric sulfide (red), and carbon (black), each mixed with an equal volume of water. Since these materials are insoluble in water they are injected as concentrated aqueous suspensions. These pigments produced no noticeable ill effects and remained clearly visible.

The lamprey larvae were anesthetized by immersing them in a 1-percent solution (by weight) of urethane. The needle of the hypodermic syringe was inserted through the skin, then held parallel to the body of the larvae and moved slowly forward; this action separated the skin from the underlying muscle. When the point of the needle had passed forward one half to three quarters of an inch from the point of insertion, a slight pressure was applied to the syringe plunger; then as the needle was slowly retracted a steady application of pressure on the plunger ejected the dye. A sharp patch of pigment remained, the size of which could easily be enlarged by a lateral movement of the needle in order to break the adhesion of the skin and muscle. Injections were made with a 2.0-cubic centimeter hypodermic syringe, equipped with a No. 22 needle. Smaller needles were not satisfactory since they quickly became plugged.

The results obtained by this method of marking were most encouraging because of the clarity and distinctiveness of the dye patches. Perhaps a more significant feature of this method is the durability of the mark. After a period of 1½ years the carbon (black) and the mercuric sulfide (red) showed no fading or dissipation of any kind. The cadmium sulfide (yellow) has held up nearly as well over six months, the period during which it has been tried. One important advantage of this method is that small lamprey larvae (30 millimeters) can be marked successfully. With animals which have a heavily pigmented skin, such as the bluish-black immature sea lamprey, it is necessary that the pigment patch be located immediately beneath the epidermis in order to insure its clarity. This method might be satisfactory with other larval vertebrates and perhaps with some invertebrates. By the use of long, narrow marks arranged as Roman numerals, a large number of individuals may be identified. Also, different color combinations may add to the number that may be marked individually.—ROLAND L. WIGLEY, *U. S. Fish and Wildlife Service, and Department of Conservation, Cornell University, Ithaca, New York.*

ADDITIONAL RECORDS OF FRESHWATER FISHES FROM TEXAS.—Recent fisheries investigations in Texas have revealed two species previously unreported from the state and additional records of the shovelnose sturgeon.

Scaphirhynchus platorynchus (Rafinesque), Shovelnose sturgeon.—It has been known for a number of years that this species occurs in the Red River system; and Baughman (1950, Tex. Jour. Sci. 2 (1): 124) listed it in his random notes, but cited only one bona fide record from Eagle Mountain Lake in 1940. Several sturgeon were reported taken in the spring of each year from the Red River tributaries near Wichita Falls prior to the construction of Denison Dam, but the first to be specifically identified was caught on May 13, 1948, on a minnow in the Wichita River, Clay County, near its junction with the Red River, by Mr. Ray McShan of Wichita Falls. This specimen was 654 mm. in total length and had the following counts: D 28; A 20; dorsal shields 19, lateral shields 48, and ventral shields 13. It was presented to the Hardin College Biology Museum, but later spoiled.

A specimen now on hand was taken in May, 1950, by an unidentified fisherman, from Shawnee Creek below Denison Dam, Grayson County. It is described as follows: total length 525 mm; D 28; A 18; dorsal shields 17, lateral shields 42, and ventral shields 12.

Hybopsis storeriana (Kirtland), Silver chub.—This minnow is usually found in large, muddy rivers and is now very common in Lake Texoma on the Red River. It is commonly found in the lake in the area known as Delaware Bend, at the northernmost boundary of Grayson and Cooke counties. This area is a shallow, inundated field near the head of the lake, where the turbidity is usually moderate.

Silver chubs make up a high percentage of the night seining collections in that section of Lake Texoma, where as many as 40 have been collected in a single seine haul.

Menidia audens Hay, Mississippi glassminnow.—This silverside was first collected in Caddo Lake, Harrison County, in July, 1950, and has been taken many times since then. It is usually found in fairly turbid water and is frequently a close associate of the brook silverside, *Labidesthes sicculus* (Cope). This species is common in Caddo Lake, where it constitutes a high percentage of the species caught by seining.

We wish to thank Dr. George A. Moore, of Okalahoma A & M College, for verifying the identification of *Menidia audens*.—E. W. Bonn and Robert J. Kemp, *Texas Game and Fish Commission, Austin, Texas.*

NOTES ON GULF OF MAINE FISHES IN 1950 AND 1951.—The following observations on marine fishes were made during the Atlantic sea herring investigation sponsored by the Maine Sardine Packers Association, the Maine Department of Sea and Shore Fisheries, and the U. S. Fish and Wildlife Service.

Carcharias taurus Rafinesque, sand shark.—On July 14, 1951, I obtained 2 immature sand sharks, 109 and 117 cm. in length, from a pound net at Small Point, Maine. According to Amby Alley, Maurice Pye, and Ted Farrin, Maine pound net operators for many years, the "dog-fish shark," as this species is commonly known in Maine, is not unusual. Farrin has estimated that he caught at least 50 specimens in 1950 and about 40 in 1951.

Lamna nasus (Bonnaterre), mackerel shark.—On August 2, 1951, contestants in the State of Maine Tuna Tournament at Boothbay Harbor caught two mackerel sharks. Since data on the length and weight relationship of this species are scant (Bigelow and Schroeder, 1948, Fishes of the Western North Atlantic, Sears Found. Mar. Res., 1 (1): 115–16), the following information on two large specimens is of value. One was a 261-cm. female, weighing 303.5 pounds; and the other, a 250-cm. male, weighing 305 pounds. The liver of the female weighed 32.5 pounds.

Cetorhinus maximus (Gunnerus), basking shark.—In answer to the request of Goeffrey Hemphill of Whitmoyer Laboratories, Inc., Rockland, Maine, I identified a 650-pound male basking shark, harpooned near Matinicus Island, Maine, on July 19, 1951. The specimen, 348 cm. in length, had the characteristic proboscis-like snout of the young of this species. The liver weight of 81.5 pounds was about 12.5 percent of the total weight; and, therefore, my rough estimate, based on the statements of Maine fish liver processors, that the liver of this species comprises 20 percent of the total weight (Scattergood, 1948, Copeia (2): 143) was probably too high. Proportional measurements in percent of total length were: tip of snout to origin of first dorsal, 38.5; tip of snout to insertion of pectoral, 25.8; tip of snout to anterior margin of eye, 7.6; origin of first dorsal to origin of second dorsal, 28.7; greatest width of first dorsal, 11.5; length of base of first dorsal, 8.7; height of first dorsal, 8.7; height of second dorsal, 2.2; length of pectoral, 14.5; length of pelvic, 7.6; length of upper margin of caudal, 22.5; and eye to eye over top of snout, 5.8.

Hyporhamphus unifasciatus (Ranzani), halfbeak.—On July 14 and 17, 1951, I saw several dozen halfbeaks in a pound net at Bald Head, Small Point, Maine. Two were captured; the rest escaped through the meshes of the net. One of the specimens was subsequently lost. The remaining one was 22 cm. long. The fishermen thought that the fish were "billfish" (*Scomberesox saurus*), which have been not uncommon in recent years in Maine waters.

Thunnus thynnus Linnaeus, bluefin tuna.—Tuna weighing less than 200 pounds are seldom seen in the inshore waters of the Atlantic coast between Portland, Maine, and St. John, New Brunswick. The capture of 22 tuna, weighing between 113 and 161 pounds, in a herring weir at Grand Manan, New Brunswick, on October 26, 1951, was an unusual event. Ten of the fish had remains of herring in their stomachs; the stomachs of the others were empty.

Seriola zonata (Mitchill), banded rudderfish.—On September 8, 1950, Fred B. Higgins, Jr. caught a 19-cm. banded rudderfish in one of his lobster storage cars in Boothbay Harbor, Maine. The fish was kept alive for several months in the federal-state aquarium at Boothbay Harbor, Maine.

Centropristes striatus (Linnaeus), black sea bass.—A 25-cm. specimen was taken on July 23, 1951, in a pound net at Pemaquid Point, Maine, and was kept alive at the Boothbay Harbor aquarium during the summer and fall. All the Maine pound net operators, who usually have about ten nets between Cape Elizabeth and Pemaquid Point, are familiar with this species, which, however, is never abundant enough in Maine to be commercially important.

Stenotomus chrysops (Linnaeus), northern scup.—On July 14, 1951, I obtained 3 scup, 194, 202, and 210 mm. long, from a pound net at Bald Head, Small Point, Maine. This species was considered unusual by Maurice Pye, the pound net operator; however, at the Johns Bay, Maine, pound nets owned by Ted Farrin, a few scup have been caught each year for at least the past quarter century.

Stephanolepis hispidus (Linnaeus), common filefish.—Warren Hume of the Maine Department of Sea and Shore Fisheries brought to the laboratory a 14-cm. filefish which was caught in a lobster trap

at the mouth of the Kennebec River on October 2, 1950. On October 14, 1950, Fred B. Higgins, Jr. brought me a 10-cm. specimen from Boothbay Harbor. The latter was also taken in a lobster trap.

Mola mola (Linnaeus), ocean sunfish.—On July 8, 1951, a fisherman gaffed a 117.5-lb. specimen near Damariscove Island in Boothbay Harbor, Maine. Its total length and greatest body depth were 96 cm. and 64 cm., respectively. The oil was extracted from the 2.2-kg. liver, and a sample was sent to the U. S. Fish and Wildlife Service technological laboratory in Seattle where F. Bruce Sanford and David T. Miyauchi analyzed the vitamin A content. The oil had only 390 spectrophotometric units of vitamin A per gram.

Prionotus carolinus (Linnaeus), common sea robin.—Several times during the summer of 1951, sea robins were brought alive from the Johns Bay pound nets to the Boothbay Harbor aquarium, where they lived for several months. On July 14, 1951, I collected 6 specimens at a Small Point pound net. These ranged in length between 26 and 33 cm. Sea robins are regular visitors to all Maine pound nets, although never in large numbers.

Echeneis naucrates Linnaeus, shark remora.—On July 17, 1951, I obtained a 51-cm. shark remora from a Small Point, Maine, pound net.

Urophycis tenuis (Mitchill), white hake.—Bigelow and Welsh (1925, Bull. U. S. Bur. Fish., 40 (2): 445) stated that the maximum length of this species is about 3½ feet, and its weight 30 pounds. On June 25, 1951, at F. J. O'Hara & Sons' Eastport wharf, I saw a hake 4 feet long and weighing 28¾ pounds with the viscera removed. The weight of the round fish would have been over 35 pounds. This was not an unusually large fish, according to the local Bay of Fundy fishermen, who said that white hake up to 40 pounds have been caught every summer. This fish had been purchased from a Wilsons Beach, New Brunswick, fish dealer, who bought the fish from a Campobello Island line trawler. I have since examined the lots of hake at F. J. O'Hara & Sons on six occasions, but have not seen any specimen larger than that of June 25. I believe that an intensive search would lead to the discovery of large white hake, probably in excess of 40 pounds.

Pseudopleuronectes americanus americanus (Walbaum), winter flounder.—On October 1, 1950, a large female winter flounder was caught by rod and reel in Boothbay Harbor, Maine. The fish was 58 cm. in total length, thus exceeding the former size record of 56 cm. for this species (Morrow, COPEIA, 1948 (3): 186). The standard length was 48 cm., the greatest width across the body, 33.5 cm., and the weight, 1710 gm. The scales had seven clear annuli and a periphery of indistinct growth marks. There were 3 + 8 gill rakers, 65 dorsal rays, 47 anal rays, 10 pectoral rays, and the dentition was $\frac{2+15}{2+15}$. As with the white hake, I believe that larger winter flounders could be found in Maine waters, if a search were effected.

The sand shark, halfbeak, rudderfish, black sea bass, scup, filefish, ocean sunfish, sea robin, and shark remora have been considered rare visitors to Maine waters according to Bigelow and Welsh (*op. cit.*) and Bigelow and Schroeder (1936, Bull. U. S. Bur. Fish., 48).—LESLIE W. SCATTERGOOD, *U. S. Fish and Wildlife Service, Boothbay Harbor, Maine.*

SYSTEMATIC NOTES ON THE OCEANIC FISHES OF THE GENUS *LOPHOTUS*.—Despite the relatively small number of specimens that have been taken, the fishes belonging to the genus *Lophotus* have attracted a good deal of interest because of their unusual size, shape, and striking coloration. The most recent specimen reported is apparently the individual described and figured by Goin and Erdman (1951, COPEIA, (4): 285, pl. I) from Clearwater, Florida. These authors have identified this specimen with *L. lacepedei* Giorna, a species originally described from the Mediterranean, and they consider this to be the only species in the genus.

A survey of the available literature on the genus *Lophotus* strongly indicates that actually two species are recognizable because the form found in the Mediterranean and off the Madeira Islands is quite distinct from those specimens that have been taken from the Western North Atlantic, South Atlantic and Pacific oceans. The differences become especially obvious when figures of the two forms are compared. Fortunately several excellent illustrations exist. Figures of the Mediterranean-Madeira species show that: (1) The first dorsal spine is modified into a strong, greatly elongate, compressed, blade-like structure which is more than twice the length of the head. The drawing in Valenciennes (*in* Cuvier, 1836, Regne Animal, 7: 152, pl. 70) is the best executed. A smaller figure, which may have been copied from the one used by Valenciennes, is included in Griffini (1903, Ittiologia Italiana: 378, fig. 202). Other illustrations of this species, in Cuvier (1813, Ann. Mus. Hist. Nat. Paris, 20: 393, pl. 17) and in Cuvier and Valenciennes (1835, Histoire Naturelle des Poissons, 10: 405, pl. 301), were drawn from specimens that had this dorsal structure broken off. An examination of these plates reveals the lower portion of this apparatus, indicating that the structure must have been as well developed as those found on the undamaged individuals. (2) The dorsal fin extends continuously backward from the lower portion of the first large spine with no noticeable decrease in its height until

the caudal region is approached. (3) The shape of the supra-occipital crest is distinctive. Especially noticeable is the fact that, in lateral outline, this crest slopes downward from its most anterior point, giving a marked concave appearance to the top of the head. (4) The supra-occipital crest also projects strongly forward, in lateral outline, from that portion of the head directly in front of the eye.

The best illustration of the only other obvious species in the genus (*Lophotes fiski* Günther is considered to be generically distinct) is given in Temminck and Schlegel (*in* Siebold, 1842–50, Fauna Japonica: 132, pl. 71). This form, *Lophotus capellei* Temminck and Schlegel, is also figured in Boulenger (1900, Mar. Invest. S. Africa, 1: 13, pl. 4). The photograph presented by Goin and Erdman (*loc. cit.*) is almost certainly of this species. These illustrations, together with such descriptions as are available, show that *L. capellei* possesses several obvious characters which separate it from *L. lacepedei* Giorna, as shown by the following (see also Fig. 1): (1) The first dorsal spine is comparatively short and weak, somewhat less than the length of the head. (2) This first dorsal spine is followed by progressively smaller spines or rays until a low point is reached above the anterior edge of the eye. Posteriorly from this point the rays, together with the fin membrane, gradually increase in height. As a result the dorsal is almost completely separated into two parts, a short section on the front of the supra-occipital crest and the main portion extending back to the caudal region. In this species, even if the first dorsal spine becomes broken off, this front section of the fin should still be distinct as a small tuft of elongate spines or rays (exactly as it appears in the photograph of the Florida specimen in Goin and Erdman). (3) In lateral outline, the top of the supra- occipital crest extends posteriorly in virtually a straight line, merging with the dorsal outline of the rest of the body of the fish. (4) This supra-occipital crest projects only slightly forward, in lateral outline, from that portion of the head in front of the eye.

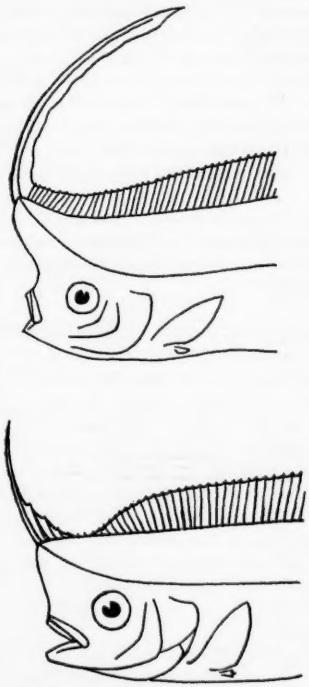


Fig. 1. Outline drawings of the head region of *Lophotus lacepedei* (above) and *L. capellei* (below).

In consideration of this information, it is concluded that the genus *Lophotus* is separable into at least two distinct species and that, for the present, the 1951 Florida specimen (U. S. National Museum No. 151118) must be identified with *L. capellei* rather than with *L. lacepedei*.—JOHN C. BRIGGS, *Natural History Museum, Stanford University, California.*

TRI-SODIUM PHOSPHATE AS A STORAGE MEDIUM FOR OTOLITHS.—Clemens (1951, Trans. Amer. Fish. Soc., 80 (1950): 163–173) has shown the merit of tri-sodium phosphate as a storage medium for otoliths. We concur, having used it for otoliths of the burbot (*Lota lota lacustris*) and the arctic char (*Salvelinus alpinus*). However, we have found that inks often used by ichthyologists for labelling (Higgins Engrossing Ink and Higgins Eternal Black Ink) are not permanent in tri-sodium phosphate. After three to four months much carbon has fallen from the labels and they can be read only with difficulty. Presumably other carbon inks would be similarly affected. Persons using this chemical should label with pencil.—C. RICHARD ROBINS AND RICHARD H. BACKUS, *Department of Conservation, Cornell University, Ithaca, New York.*

FIRST RECORD OF THE DOLLY VARDEN, *SALVELINUS MALMA*, FROM NEVADA.—According to Gilbert and Evermann (1894, Bull. U. S. Fish Comm., 14: 201) and Schultz and DeLacy (1935, Jour. Pan-Pacific Res. Inst., 10 (4): 374), this species is common in the upper Columbia River drainage, but uncommon in the Snake River drainage. In a letter to the junior author dated October 16, 1951, James C. Simpson, Fish Culturist of the State of Idaho Department of Fish and Game, wrote: "To the best of my knowledge, at the present time there are no Dolly Varden in the Wood

or Weiser Rivers. However, there are some still taken from the Payette River system. In all of my fish collecting work I have not taken a Dolly Varden trout above Shoshone Falls." So far, however, this species does not appear to have been recorded from the Snake River system except in Little Lost River, Idaho (which enters the Snake above Shoshone Falls), where Hubbs and Miller (1948, Bull. Univ. Utah, 38 (20): 76) regarded it as a probable glacial relict. It once may have occurred in the adjacent Bonneville system of Utah and Idaho (Rostlund, 1951, COPEIA (4): 296), to which the upper Snake fish fauna is closely allied. *Salvelinus malma* (Walbaum) has never been reliably reported from the state of Nevada. The recent listing of this species from northeastern Nevada by La Rivers and Trelease (1952, Calif. Fish and Game, 38: 115) was based on testimony only, but subsequently three specimens were collected and are recorded below.

On August 27, 1934, while making a survey of the waters of Humboldt National Forest for the U. S. Bureau of Fisheries, S. D. Durrant collected two Dolly Varden in Dave Creek, 4 miles above its junction with the East Fork of Jarbidge River, T47N, R9E, Sec. 25, Elko County, Nevada (see map of Humboldt National Forest, U. S. Forest Service, 1942 ed.). This locality lies about 4½ miles south of the Nevada–Idaho line and approximately 4½ miles northeast of Jarbidge. Jarbidge River is a tributary of the Bruneau River which enters the Snake River about 100 miles below the impassable Shoshone Falls. The larger specimen (deposited at the University of Michigan) is a mature male with swollen testes and is about 169 mm. in standard length, and the smaller one (at the University of Utah) is an immature fish 105 mm. long.

Morphological measurements and meristic counts, made on these two specimens by the junior author, fall within the known range of variation for the species. The only other species of *Salvelinus* that might reasonably be expected to occur in this area is *S. fontinalis* (Mitchill), which has been introduced with varying success in many western streams. The absence of dark spots on the dorsal or caudal fins and the relatively high vertebral counts (67 and 64, including the hypural) provide the best evidence that these specimens are *malma* rather than *fontinalis*. Subspecific allocation is reserved, pending a revision of *Salvelinus* by one of us (Morton).

Three additional specimens of *S. malma*, all males, are in the collection of the Department of Biology, University of Nevada. They were identified by Ira La Rivers and T. J. Trelease and were collected by Earl Dudley, a warden of the Nevada Fish and Game Commission, on July 5, 1951, on the East Fork of the Jarbidge River. Their standard lengths, in mm., are 168, 190, and 193.

This species still occurs in at least one Snake River tributary, but it is evidently uncommon in northern Nevada for a recent survey of most of the streams of that area failed to reveal any specimens (Miller and Miller, 1948, COPEIA (3): 174–87). Whether it may have been planted in this region (Trelease and La Rivers, *loc. cit.*) is open to question as the Nevada hatchery superintendent who claims to have handled the Dolly Varden kept no records and may have been mistaken (La Rivers, *in litt.*, March 17, 1952).

We are greatly indebted to Professor Durrant, of the University of Utah, who called the attention of the senior author to the 1934 specimens, and also wish to thank Professor A. M. Woodbury, Head of the Department of Vertebrate Zoology, University of Utah, for permission to study and report on the material and for the gift of one of the specimens. Our thanks are also due Ira La Rivers and T. J. Trelease who supplied the data on the three specimens at the University of Nevada.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan,* AND WM. MARKHAM MORTON, *U. S. Fish and Wildlife Service, Swan Island, Portland, Oregon.*

OBSERVATIONS OF AGE AND GROWTH IN THE MENHADEN (*BREVOORTIA TYRANNUS*) AS DETERMINED BY SCALE EXAMINATION.—This study is based on examination of scales from 34 menhaden, *Brevoortia tyrannus* (Latrobe), taken in November and December, 1949, and January, 1950, by Mr. John Robas, a commercial fisherman operating out of Beaufort, North Carolina. Measurement was made from the tip of the lower jaw to the fork of the tail, and is the median or fork length as defined by Ricker and Merriman (1945, COPEIA (4): 184–91). The sample is small and the application of results is limited accordingly.

Gratitude is expressed to Mr. Clinton E. Atkinson for helpful comments and suggestions, to Mr. James E. Sykes for assistance in preparing the accompanying graph, and to Mr. Charlie L. Perkins for assistance with parallel scale readings.

Four scales taken from below the dorsal fin were soaked in water, cleaned by rubbing between the fingers, and mounted in glycerin jelly for examination. The criteria for determining true annuli as established for the Pacific pilchard by Walford and Mosher (1943, U. S. Fish and Wildlife Serv., Spec. Sci. Rept., 3 (12): 4 pp.) were followed in this examination. Thus, a mark herein referred to as an annulus is one which was observed to be concentric with the margin of the scale, traceable entirely around the sculptured portion, and found in all normal scales from an individual. As here used, "annulus" refers

only to the nature of the mark, not to periodicity of its formation.

Scales varied in clarity, some being clearly marked, with each mark a true annulus as here defined, others exhibiting poorly defined annuli and numerous "false annuli," which partially met the criteria. Scales of the latter type could be read with difficulty, and only after careful examination of a number of scales from the individual. Scales with four or more annuli often exhibited peripheral crowding of annuli with intermingling of other distinct marks, presumably spawning checks. In such scales, peripheral annuli could be traced only with difficulty. In no case was an annulus found to be in close proximity to the margin in any scale exhibiting less than four annuli.

The 34 samples were read independently by the author and by a co-worker. The first reading produced 22 agreements as to number of annuli. A second reading of the 12 disagreeing samples produced agreement in 9 cases. Consultation produced agreement in one of the 3 remaining cases. In the other 2, it was necessary to mount and examine additional scales from the original samples. The final agreed results are given in Table I.

TABLE I

COMPARISON OF OBSERVED AND CALCULATED LENGTHS OF MENHADEN (*Brevoortia tyrannus*) AT VARIOUS AGES

Annuli	Observed		Calculated	
	Number of fish	Mean length in inches	Number of fish	Mean length in inches
0	5	4.5	34	....
1	3	7.3	29	4.6
2	10	10.2	26	8.4
3	4	11.7	16	11.3
4	6	13.4	12	12.8
5	4	13.8	6	13.6
6	2	14.4	2	14.1

The length of each of the 34 fish at the time of formation of each annulus was calculated from scale measurements made with a 12-power binocular dissecting microscope. Measurement to the nearest estimated $\frac{1}{10}$ millimeter was from the focus through the middle of the sculptured portion of the scale. For each fish and each annulus, computations were made from 2 scales. When agreement was within $\frac{1}{4}$ inch, as usually happened, the average was taken as the final calculated length. When the difference was greater than $\frac{1}{4}$ inch, a computation was made from a third scale, and the average of the three taken as the calculated length. These values (Table I) will be regarded as expected lengths for this species at the time of formation of the respective annuli. The calculated lengths consistently lie between the observed lengths, which agree well with the time of annuli formation in the early summer and the time the sample was collected during the late fall and winter.

Annulus groups were plotted against the measured fork length, and the resulting curve is shown in Figure 1. When this curve was transformed by the method described by Walford (1946, Biol. Bull., 90 (2): 141–47), the observed means were found to gather closely about a straight line, indicating that the curve reflects a normal growth pattern. Most rapid growth occurred in the first three years when the menhaden attained an average length of 11.3 inches. The oldest fish (6 years old) averaged only 14.1 inches in length, increasing less than 3 inches in their last 3 years of life.—WILLIAM A. RUSH, *U. S. Fish and Wildlife Service, Beaufort, N. C.*

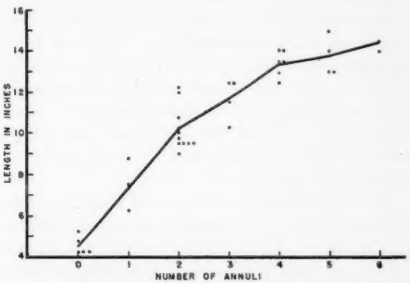


Fig. 1. Individual lengths of menhaden (*Brevoortia tyrannus*) and the mean for each age group in sample taken off Beaufort, N. C., November 1949–January 1950.

THREE SPECIES OF FISHES, GENUS *SERIOLA*, IN THE WATERS OF CAPE COD AND VICINITY.—While engaged in a study of tuna made jointly by the U. S. Fish and Wildlife Service and the Woods Hole Oceanographic Institution, I had occasion during the summer of 1951 to observe three species of *Seriola* in Cape Cod waters, *Seriola zonata* (Mitchill), *Seriola dumerili* (Risso), and *Seriola fasciata* (Bloch).

The banded rudderfish (*Seriola zonata*) is a more or less regular summer visitor to the southern side of Cape Cod, but there have been few records of it from the north coast. In the summer and fall of 1950 and again in 1951, however, I often saw a dozen or more of this species among the landings from the traps in Cape Cod Bay at Barnstable. Twelve individuals obtained there from the trap of Captain John Vetorino ranged from 15 to 23 cm. in standard length, which is about the size-range of the others I have observed around the Cape. Captain Vetorino reports that the species has occurred regularly off Barnstable in recent years but was exceptionally abundant in the years 1949–1951. From one day's

catch in this period he shipped two barrels of rudderfish to market. He also related that when the trap poles are pulled up in late October he frequently sees six or seven rudderfish gathered around each one, feeding on the animals which are shaken from it. Mrs. Marie Poland Fish, of the Narragansett Marine Laboratory, reports that in 1951 she obtained 15 specimens from traps near Point Judith, Rhode Island, and one from the Woods Hole Aquarium, all less than 20 cm. long.

The amberjack, (*Seriola dumerili*), is much less common in Cape Cod waters. Sumner, Osburn, and Cole (1913, Bull. U. S. Bur. Fish., 31 (1911): 751) listed this fish as occasional only. There are seven specimens from this area in the U. S. National Museum, and one in the American Museum of Natural History. All of these records date from many years ago, however, and I have been unable to find recent occurrences either in the literature or by questioning fishermen.

It therefore seemed of more than passing interest when we took 17 of these amberjacks while trolling for school tuna 10 to 15 miles south of No Mans Land (an island 17 miles south of the Massachusetts coast) in September, 1951. These fish ranged from 19 to 23 cm. in length, and despite their small size, they struck at tuna feathers and white marlin baits. They were concentrated under boxes, planks and patches of weed in a drift row. Several of these specimens are now at the Harvard Museum of Comparative Zoology.

A specimen of *Seriola fasciata* 19 cm. long was taken off No Mans Land along with the amberjacks. This little-known species was first figured by Bloch (1793, Ichthyologia, pl. 341) as *Scomber fasciatus*, with no locality given. Cuvier and Valenciennes (1833, Hist. Nat. Poiss., 9: 211) described the fish (under the name *Seriola fasciata*) and gave the first locality record for it (Carolina). Later authors who referred to it are: Gill (1863, Proc. Acad. Nat. Sci. Phila., 14 (1862): 442), who called it *Zonichthys fasciatus*; Jordan and Evermann (1896, Bull, U. S. Nat. Mus., 47: 904), who gave a description of *Seriola fasciata*, defined its range as West Indies to Charleston and listed Poey's names *Halactractus fasciatus* (1868) for the banded form and *Seriola semicoronata* (1860) for a phase without bands (which I have not seen); Jordan and Thompson (1905, Bull. U. S. Bur. Fish., 24 (1904): 237), who cited young specimens collected at Tortugas; Longley and Hildebrand (1941, Carnegie Inst. Wash. Publ. 535: 76), who placed this latter record in the synonymy of *Seriola dumerili*; and Fowler (1920, Proc. U. S. Nat. Mus., 56: 228; and 1936, Bull. Amer. Mus. Nat. Hist., 70: 679), who described 13 small specimens 10 to 12 cm. long taken off West Africa.

Museum specimens are not numerous. In addition to the No Mans Land specimen, the Harvard Museum of Comparative Zoology has one, 17 cm. long, from Cuba. Isaac Ginsburg has identified five at the U. S. National Museum, all less than 7 cm. long, as of this species. These are, respectively, from Long Island, N. Y., Cape Charles, Va., Beaufort, N. C., the Tortugas, Fla., and an unknown locality. Therefore, the capture of the Cape Cod specimen is noteworthy, for it is the most northern record for this species.—FRANK J. MATHER III, *Woods Hole Oceanographic Institution, Woods Hole, Massachusetts* (Contribution No. 599).

A NORTHERN RECORD OF THE WHITE CRAPPIE FROM LAKE HURON, ONTARIO, CANADA.—A specimen of the white crappie, *Pomoxis annularis* Rafinesque, measuring 9.0 inches in fork length and weighing 170 grams, was taken on July 29, 1950, from South Bay on the Manitoulin Island shore of Lake Huron, Ontario. Radforth (1944, Contr. Roy. Ont. Mus. Zool., No. 25: 95) included the white crappie with Ontario species having Mississippi River affinities, and showed, on her distribution maps, Ontario records only from Lakes Erie and St. Clair. According to J. Murray Speirs (personal communication), who is making a study of Great Lakes distribution records, the white crappie has not been previously reported from Lake Huron. The preserved specimen is now in the fish collection of the Royal Ontario Museum of Zoology in Toronto.—J. C. BUDD, *Department of Lands and Forests, Toronto 5, Canada.*

AN "UNUSUAL" YELLOWFIN TUNA (*NEOTHUNNUS MACROPTERUS*) FROM THE WATERS OF THE NORTHERN LINE ISLANDS IN THE CENTRAL PACIFIC OCEAN.—During an exploratory fishing cruise of the U. S. Fish and Wildlife Service vessel, HUGH M. SMITH, in waters of the central Pacific Ocean in May and June, 1951, a female tuna, weighing 24 pounds, was captured which differed distinctly from the fish being landed from a surface school of yellowfin tuna (*Neothunnus macropterus* Temminck and Schlegel). The specimen was caught by hook and line on June 1 while chumming off Palmyra Island, 1½ miles WSW of Sand Island, where water depths exceed 2000 fathoms.

The coloration of the fresh specimen was striking: the upper surface of the body was steel-blue, shading into silvery-gray on the sides and white on the belly; a series of oblique transverse pale silvery lines, alternating with similarly colored rows of dots, was present on the side, the latter forming an irregular pattern on the caudal peduncle; the first and second dorsals, anal, and caudal fins were dusky and edged with black; the anterior one-third of the pectoral fins was silvery-gray, shading into dusky posteriorly and edged with black; both the dorsal and

anal finlets were jet black; the body and fins were without yellow markings.

Based on these external color markings, the specimen at first appeared to be a bluefin tuna, either *Thunnus thynnus* (Linnaeus) or *Thunnus maccoyi* (Castelnau), except for the oblique transverse silvery bars on the sides of the body, the black finlets, and the pectoral fins; the latter are much longer than is

TABLE I

MEASUREMENTS, IN MILLIMETERS, AND MERISTIC COUNTS OF AN "UNUSUAL" SPECIMEN OF *Neothunnus macropterus* CAPTURED IN THE LINE ISLANDS IN JUNE, 1951

Total length (fork length)	863
Head length	241
Snout to origin of first dorsal fin	265
Snout to origin of second dorsal fin	459
Snout to origin of anal fin	504
Snout to insertion of ventral fin	276
Insertion of ventrals to anterior edge of vent	244
Greatest body depth	216
Pectoral fin, length	234
Pectoral insertion to origin of first dorsal	126
First dorsal, basal length	196
Second dorsal, basal length	93
Spread caudal (fin was frayed)	275
Longest dorsal spine, length	97
First dorsal spine, length	97
Second dorsal fin, length	136
Anal fin, length	140
Length longest dorsal finlet	32
Iris, diameter	36
Maxillary, length	97
Caudal peduncle, least depth	22
Caudal peduncle, greatest width at keels	80
Spines in first dorsal	14
Rays in second dorsal	14
Dorsal finlets	8
Rays in anal	14
Anal finlets	8

common in either of these species of comparable size. Furthermore, the gill-raker count precluded its assignment to either of these species. Godsil and Holmberg (1950, Calif. Div. Fish and Game, Fish Bull. 77: 1–55) gave gill-raker counts for *T. thynnus* and *T. maccoyi* as 10 to 15 + 21 to 25, and 12 + 22 to 24, respectively. This specimen has a gill-raker count of 9 + 21 on the first gill arch of both the right and left sides, which is clearly within the range for the yellowfin tuna, *Neothunnus macropterus*. Also, the specimen differed from *Kishinoella tonggol* Bleeker, the latter having a gill-raker count of 5 to 8 + 14 to 17 (Serventy, 1942, Jour. Council Sci. and Ind. Res., 15 (2): 101–12).

Other meristic counts and measurements, after the methods of Marr and Schaefer (1949, U. S. Fish and Wildlife Service, Fish. Bull. 47: 241–44), were made aboard the vessel at the time of capture, and are presented in Table I. These measurements consistently fall within the range of variation for *Neothunnus macropterus* of comparable size, but lie outside the ranges for other tuna species for which there are published data.

An examination of the internal anatomy (made after three month's preservation in formalin) showed the following features: The apex of the caecal mass is located on the right side of the body, which appears to be rather uncommon in the tunas. The liver is composed of three lobes, the right lobe the longest. The central portions of all three lobes lack black striations on the ventral surfaces; however, these surfaces are marked inconspicuously with a very fine network of blood vessels on the central portions and along the edges. Furthermore, a swim bladder is present which occupies nearly two-thirds the length of the body cavity; in shape and size it is comparable to the descriptions of this structure in *Neothunnus macropterus* as given by Godsil and Byers (1944, Calif. Div. Fish and Game, Fish. Bull. 60: 54–57).

Based on the morphometric measurements, gill-raker counts, the plain ventral surfaces of the lobes of the liver and the presence of a well developed swim bladder, the specimen tentatively is identified as an unusual *Neothunnus macropterus*.

Verbal information obtained from Mr. Phil Palmer, Manager of the Fanning Island Plantation, Ltd., indicated that tunas similar to that described above occasionally have been caught in the waters off Fanning Island. It is possible that the specimen represents a race that has become established in the Line Islands area. The specimen is preserved at the Pacific Oceanic Fishery Investigations laboratory as POFI Cat. No. 5314.—FRED C. JUNE, *U. S. Fish and Wildlife Service, Box 531, University of Delaware, Newark, Delaware.*

Reviews and Comments

HANDBOOK OF TURTLES. By Archie Carr. Comstock Publishing Associates, Ithaca, New York, 1952: xv + 542, 37 figs., 82 pls., 23 maps. $7.50.—This is an excellent book on the turtles of the United States, Canada, and the Mexican state of Baja California. In the introductory section there are discussions of the physiology, anatomy, behavior and origin of turtles as well as their economic role and their impact on folklore. The greater part of the book is devoted to accounts of species and subspecies, each account headed by a common and the scientific name and, generally, each is treated from the standpoint of range, distinguishing features, description, habitat, habits, breeding, feeding, and economic importance. The ranges of all turtles listed, with the exception of the seaturtles, are shown on maps. There is a key to the families represented in the area covered, and keys, in their appropriate sections, to the lower categories. Seventy-two of the seventy-nine species and subspecies listed are illustrated by halftones from photographs. The text figures are line drawings illustrating osteological features, scale arrangements and color pattern.

The book has remarkably few typographical errors, the format is attractive, and the illustrations, except for one or two, are excellent. A drawing of the sagittal section from head to tail would have enhanced the section on anatomy, especially since no mention is made of the limbs and girdles.

Carr proposes standardizing the names of the horny scutes and bony plates of the carapace, basing his scheme, with some modification, on the terminology used by Dr. Leonhard Stejneger. The degree to which the author follows his own proposal in the subsequent pages almost attains 100 percent.

The scheme of classification adopted by the author is that of O. P. Hay (1908) in which the suborder Athecae includes only the strangely built seaturtle, *Dermochelys*, and the Thecophora includes all the rest of the turtles, living and extinct. It is refreshing, in this day and age, to see someone adopt an existing classification rather than invent a new one. The name combinations of the lower categories are in general accordance with current usage; all departures from the last edition of Stejneger and Barbour's *Checklist* are indicated, as are those from post-*Checklist* literature. Carr's usage of names for some of the forms of *Graptemys* and some of the seaturtles is with full realization that detailed systematic studies are in order.

A glaring factual misstatement in the book (p. 7) is that the male copulatory organ of turtles is an unforked penis. This is certainly a lapsus on the author's part for he must be well acquainted with the bizarre (for a turtle) multiforked penis of the softshell, *Amyda*.

The *Handbook of Turtles* was a long time in preparation and in press; no literature published after 1949 is listed in the 69-page bibliography. Mrs. Stickel's very excellent paper on populations and home ranges of the boxturtle, *Terrapene carolina*, was not utilized in the text but is listed in the bibliography, and one can only conclude that Carr's manuscript had reached the unalterable stage when her paper appeared. Likewise, Ernest Williams' paper (1950) on cervical vertebrae, had it been available at the proper time, *might* have induced the author to modify the scheme of classification. However, whether a group is called a suborder or a superfamily, or another a family or a subfamily, leaves the reviewer as untouched as it probably does the author.

The author's method of approach and his style are highly individualistic and uninhibited. His friends and admirers will love this unorthodox handbook and will chuckle many times and will often quote sections from it, sections (such as personal anecdotes) that will not be so appealing to others. Parts will remind some readers of Will Cuppy and even Uncle Remus. All will be aware of the humor pervading the pages of this book and many will detect statements written with tongue in cheek. At least one sentence was subtle enough in meaning to escape the sharp scissors of the Comstock editors.

All in all, this is a most excellent book lucidly written by a man who has an exceptional knowledge of the turtles of the Americas. It should be in the library of every naturalist and will be appreciated most by those who can appreciate the author's whimseys.—Norman Hartweg, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

SCHÖNE FISCHBÜCHER; KURZE GESCHICHTE DER ICHTHYOLOGISCHEN ILLUSTRATION; BIBLIOGRAPHIE FISCHKUNDLICHER ABBILDUNGSWERKE. By Claus Nissen. Im Lothar Hempe Verlag, Stuttgart, Germany, 1951: 108 pp. $2.25.—This is a thumbnail sketch of the history of ichthyology and a survey of the evolution of piscatorial art. The introduction mentions prehistoric, Roman, and Medieval drawings of fishes, but the nucleus of the book is devoted largely to a survey of the important illustrated fish books with notes on the artists employed. It is clear that Nissen regards fish illustrators as a neglected

clan, and he mentions them throughout the text and bibliography.

His attack is much like that employed by Casey Wood in *An Introduction to the Literature of Vertebrate Zoology*. The book pays tribute to the artists who were responsible for complementing the scientific accuracy of the early ichthyologists. Most of the books mentioned are restricted to literature published roughly from 1500 to 1900, but the dated bibliography does cite Vesey-Fitzgerald (illustrator for LaMonte's *Game Fish of the World*, 1949) and nothing else of importance between 1900 and 1950. In America and elsewhere tremendous strides have been made in ichthyological illustration as an adjunct to faunal studies.

Nissen's booklet is divided into five sections: (1) historical review; (2) a bibliographic ichthyology containing 25 entries; (3) catalogue of illustrated books with 135 entries; (4) annotations; and (5) index. The book, duodecimo in size, is bound in boards. The type is roman, large, and easily read; in fact, this volume might easily be recommended as a pleasant introduction both to German and to fish literature.—Romeo Mansueti, *Maryland Department of Research and Education, Solomons, Maryland.*

THE FISHES OF THE INDO-AUSTRALIAN ARCHIPELAGO. IX PERCOMORPHI (concluded), BLENNIOIDEA. By L. F. de Beaufort with the collaboration of W. M. Chapman. E. J. Brill, Leiden, Netherlands, 1951: xi + 484, 89 figs. Gld. 45 (= approx. $12.00).—This is the ninth volume of the series which was started by Weber and de Beaufort in 1911. The present volume concludes the order Percomorphi introduced in Volume 5, 1929. The other order treated in volume 9, Blennioidea, was authored by de Beaufort and Chapman. The latter was responsible for the 8 genera of salariian blennies. The purpose of this great work is to furnish the means of identifying fishes in the faunal region treated.

The following new names and new species were proposed: *Acanthurus fowleri*, new name for *Hepatus pyroferus* Fowler and Bean, p. 149; *Alticus triangulus* Chapman, new species, p. 269; *Alticus semicrenatus* Chapman, new species, p. 270; *Salarias bleekeri* Chapman, new species, p. 338.

I have made active use of this series for many years and find the volumes invaluable, especially in giving an additional treatment and interpretation of many of the specimens and species described and figured by Peter Bleeker, one of the most astute ichthyologists of all times on the tropical Indo-Pacific fishes.

Certain families are well done, such as the Acanthuridae, whereas in others, critical characters were omitted, and the keys, text, and figures may lead to the wrong identification for the following reasons: (1) The fauna of the tropical Indo-Pacific is so extensive that almost any collector may obtain species not treated in Volumes 2 to 9. (2) The importance of the basic color pattern of reef fishes as a factor in recognition of species and of subspecies occupying island groups or subfaunal areas was not fully appreciated or understood except for the salariian blennies. (3) Statistical tables of counts and measurements would have made possible a more complete analysis of species and of subspecies. (4) An analysis of statistical data and of details of basic color pattern would have helped to demonstrate that a certain percentage of the species of the Indo-Australian Archipelago are specifically or subspecifically distinct from similar ones in different faunal areas. (5) More illustrations would make the volumes of greater use to laymen.

I have studied in detail many genera and species included in Volumes 2 to 9 and have reached conclusions differing from those presented. These differences may be attributed to: (1) my study of large series of additional specimens of a species or of several species not available to the authors; (2) different points of view in regard to the constancy or variability of the basic color patterns; and (3) my use of statistical tables of counts and measurements. Although these differences are too complicated and numerous to discuss in a review, some have been published by me and by Dr. E. A. Lachner, and others will appear in publications now in press by the same authors.

The summary of modern ichthyological literature under each species is valuable, but it is necessary to turn to Fowler's numerous publications on tropical Indo-Pacific fishes to locate quickly the plate and figure numbers omitted in Volumes 1 to 9.

In general, this volume, along with the other eight, will continue for years to be of great usefulness to all fish students. They are a necessity in any ichthyological library.—Leonard P. Schultz, *U. S. National Museum, Washington 25, D. C.*

MERISTIC VARIATIONS AND POPULATIONS OF NORTHERN ANCHOVY (*Engraulis mordax mordax*). By J. L. McHugh. Bull. Scripps Inst. Oceanogr., Univ. Calif., 6 (3): 123–160, figs. 1–9; 1951. 35 cents.—At least three populations of this anchovy occur in the range of the subspecies, from British Columbia to southern Baja California. An inverse relationship exists between the mean number of meristic elements and the water temperature during the fixation period. This relationship is confirmed by studies of seasonal variations in mean numbers of vertebrae and fin rays in postlarvae.

THE FOOD OF ALBACORE (*GERMO ALALUNGA*) OFF CALIFORNIA AND AAJA CALIFORNIA. By J. L. McHugh. *Ibid.*, 6 (4): 161–172, figs. 1–4; 1952. 25 cents.—Examination of stomach contents of 321 albacore indicates that the species feeds on a wide variety of organisms, mostly of small size. Fishes are dominant, with the Pacific saury (*Cololabis saira*) making up almost 50 percent of the total food volume. As a group, squids are the most important invertebrate food. Latitudinal, annual and seasonal variations in diet are reported. Food of albacore in the eastern Pacific and eastern Atlantic is remarkably similar in composition. It is possible that the availability of albacore is dependent upon the movements and abundance of *Cololabis*.

BILLY BASS. By R. W. Eschmeyer. Fisherman Press, Inc., Oxford, Ohio, 1951: 46 pp., illus.

TOMMY TROUT. By R. W. Eschmeyer. *Ibid.*, 1951: 48 pp., illus.

BOBBY BLUEGILL. By R. W. Eschmeyer. *Ibid.*, 1952: 47 pp., illus.—These three booklets present, in delightfully told fashion, true-to-life stories of familiar fishes written especially for children but equally absorbing and valuable for adults. Accurate life history information is interwoven about a central theme of basic conservation, restoration and fish management which the country so sorely needs. The fundamentals of conservation education are gotten across to the reader in a most entertaining and convincing manner. Each booklet can easily be read in less than an hour and, once begun, the reader finds himself unable to put the story away until the last line has been read.

This series, which also includes stories on mammals and birds, is available in cloth at $1.50 each or in a flexible paper cover for 50 cents a piece. The booklets make ideal gifts and are a credit to Dr. Eschmeyer and the publisher. The illustrations, especially those by Maynard Reece, add much to the value of the booklets. With wide dissemination (as on newstands at airports, etc.) they will bring conservation to the American public through effective impression on the more receptive minds of younger age groups.

SOME PRINCIPLES OF MARINE FISHERY BIOLOGY. By Martin D. Burkenroad. Publ. Inst. Marine Sci., 2 (1): 177–212; 1951.—From consideration of the nature of productive relationships within marine ecosystems and from critical comparison of the studies of Pacific halibut and North Sea demersal fisheries, it appears that deductive methods may not, in the present state of marine science, permit reliable prediction of the effects of fishing. Deliberate use of the inductive method, through design of sea-fishery regulations in form equivalent to controlled experiment, may thus often be necessary for achievement of biologically effectual exploitation. The net value to society of the given purpose which would be effectually served by a given mode of exploitation is difficult to assay. However, the attendant increase in knowledge of interactions between man and environment may be of prime importance.

Editorial Notes and News

SUMMARY OF THE 1952 MEETING

THE 32nd annual meeting of the American Society of Ichthyologists and Herpetologists was held in Austin and Rockport, Texas, April 10–14, 1952. The Austin meetings were sponsored by the University of Texas and the Texas Game and Fish Commission and were held jointly with the Texas Herpetological Society. The Rockport field trip on April 14 was sponsored by the Marine Laboratory of the Texas Game and Fish Commission.

Activities of April 10

The Board of Governors' meeting was held in the East Room of the Hotel Stephen F. Austin with 25 governors present. The meeting was called to order by Vice-President George A. Moore at 8:40 P.M. The reading of the minutes was dispensed with and approved as printed in Copeia, 1951 (4): 318–319.

The 96 new members of the Society obtained since June, 1951, were elected to membership.

The following were elected to fill vacancies in the Board of Governors: REEVE M. BAILEY, FRED R. CAGLE, KENNETH D. CARLANDER, D. DWIGHT DAVIS, PAUL H. ESCHMEYER, JAMES A. OLIVER, EDWARD C. RANEY, CARL D. RIGGS, E. A. SEAMAN, HOBART M. SMITH, FRED H. STOYE, ROYAL D. SUTTKUS, JOE A. TIHEN, PERCY VIOSCA, JR., and LOREN P. WOODS.

No vacancies were reported in the list of Honorary Foreign Members.

The report of the Publications Secretary, N. BAYARD GREEN, was read by the Secretary. During the calender year 1951, a net gain of $1867.87 was realized from the sale of back numbers. As of April 1, 1952 the sum of $540.77 was at hand and $311.56 was outstanding on filled orders. Four numbers of the Old Series and ten of the New Series (1930 to date) are out of print. A printer's estimate on reproducing 100 copies of a single 96-page number of the latter was $167.88. It was recommended not to reprint numbers in either series at this time and the Board concurred. In line with a suggestion of the Publications Secretary, the Board passed a motion to give a 20% discount to members of the Society on future purchases of back numbers. Also passed was a motion to allow no discount to dealers and agents. The Board unanimously passed a resolution thanking MR. GREEN for his excellent work.

The Secretary reported on the Endowment Fund which now totals $5837.66, $4000 of which is invested in four $1000 Series E, U. S. Savings Bonds and $1837.66 in cash in a savings account in the Ithaca Savings and Loan, Ithaca, New York. The Board recommended that VICE-PRESIDENT GEORGE P. MEADE investigate the possibilities of investing the cash now available in this fund and report at the next meeting. The FREDERICK H. STOYE Fund consists of three $1000 Series G, U. S. Savings Bonds. The income is used for student awards at the annual national meeting. The Revolving Research Fund has a balance of $1420.25 in the Tompkins County Trust Company, Ithaca, New York. The only change in this fund since the last meeting was a gift of $50 from the San Francisco Aquarium Society. After a discussion of the reasons for the failure of this fund to be used more fully, a motion was passed that aside from the use specifically provided for in the By-laws, grants from the fund might be used by young members of the Society for the purchase of reprints of papers published in COPEIA or other journals. Furthermore, the intended use of the fund shall be brought to the attention of the membership by notice in COPEIA and in the notice of the annual meeting of the Society regularly sent out by the Secretary.

The board approved a motion to empower the Treasurer to send a gift of 40 pounds to the Zoological Society of London toward the publication of the 1951 Zoological Record. (Later, an anonymous member donated an additional 10 pounds to be included in the Society's contribution.)

The Society's membership in the American Institute of Biological Sciences was discussed at length. The Secretary was directed to prepare a statement giving the arguments pro and con for continued membership in A.I.B.S. and the members of the Society are to be polled with regard to continuance in A.I.B.S. The Secretary shall present a report of results at the next meeting of the Board of Governors.

The Treasurer's report was read by the Secretary. The proposed budget for the calendar year 1952, prepared by the Secretary, was adopted. Estimated income for 1952 is $7668.00. Less revenue is anticipated from the sale of back numbers and from the sale of reprints (normally a reimbursement). The latter item of business will be handled by the Waverly Press.

The next annual meeting will be held in New York City with the American Museum of Natural History acting as sponsor. The time of the meeting will be decided by the officers.

No report was received from the Historian. A motion was passed to amend Article IV, Section 1, of the Constitution to abolish the office of Historian, to delete Article VI of By-laws (which concern duties of Historian), to direct the former Historian to turn over to the Secretary of the Society the set of COPEIA, the biographical records and the miscellaneous records now in his possession. Further it was approved that this set of COPEIA be completed when possible and kept in the possession of the Secretary as a second official set of the Society. Article XII of the By-laws was amended to read as follows: "Society sets of COPEIA. Official bound sets of COPEIA shall be maintained in the offices of the Editor-in-chief and Secretary." The above action was confirmed at the business meeting on April 13.

A motion was regularly approved to amend the first two sentences of Article IV, Section 2, of the Constitution to read as follows: The officers shall be elected at the annual business meeting from among active members in good standing. The slate of nominees shall be furnished by a nominating committee of five members to be appointed by the President at or shortly after the time of the previous annual meeting. This action was confirmed at the annual business meeting on April 13.

ARNOLD B. GROBMAN presented the desire of a presently organized group of southeastern herpetologists to affiliate with the Society as a southeastern section. The Board approved a motion empowering the officers of the Society to consider a similar request for affiliation made at a later time in a more formal manner.

After considerable discussion a proposal for a SHERMAN C. BISHOP memorial number of COPEIA was referred to the Editorial Board.

EDITOR-IN-CHIEF GERALD P. COOPER reported briefly on the agreement with the new printer of COPEIA, Waverly Press. The matter of reprint costs was discussed with suggestions that lithoprinting of large papers be considered. The editors were empowered to investigate the possibilities and costs. The editors were further empowered to consider and adopt a new cover design for COPEIA. A motion was unanimously passed thanking the editors for the fine job which they have done during the past year. The meeting adjourned at 11:50 P.M.

SESSIONS OF APRIL 11

Registration was held in West Foyer, Experimental Science Building, University of Texas from 8:00 to 10:00 A.M. A registration fee of $1.00 was paid except by college students (50¢) and wives and high school students (free). The morning session was called to order in the Experimental Science Building by VICE-PRESIDENT MOORE at 10:10 A.M. DR. CLARENCE P. OLIVER, Chairman of the Zoology Department, University of Texas, welcomed the members and guests. DR. CARL L. HUBBS responded for the Society.

VICE-PRESIDENT MOORE appointed the following committees: Auditing; CARL L. HUBBS and KARL F. LAGLER. Frederick H. Stoye Awards; for ichthyology, REEVE M. BAILEY, ERNEST A. LACHNER and ROYAL D. SUTTKUS; for herpetology, COLEMAN J. GOIN, RAYMOND B. COWLES and HENRY S. FITCH. Resolutions; EDWARD H. TAYLOR, NEIL D. RICHMOND and ROBERT C. STEBBINS.

Mimeographed abstracts of papers to be read were provided but the supply will not permit a more general distribution. The following papers were read:

Some biological applications of X-ray photography.—Robert R. Miller.

The habitat basis for new herpetological records in northeastern Mexico.—Paul S. Martin.

Notes on Siren intermedia.—William B. Davis and Frank T. Knapp.

Further information on the fauna of the Dockum Triassic.—John A. Wilson.

Geoclines and Ontoclines in lizards of the genus Heloderma.—C. M. Bogert and R. Martin del Campo.

At 12:30 P.M. a group photograph was taken on the south steps of Main Building with W. W. MILSTEAD in charge. Copies of the photograph are available at $1.00 each from Gilmore Studio, 2264 Guadalupe St., Austin, Texas.

The members enjoyed a group luncheon of "Mexican food" served at "Old Seville."

The afternoon session was called to order at 2:30 P.M. by CHARLES M. BOGERT who served as moderator for a symposium entitled "The Species as a Natural Population." The following papers were given:

Speciation in the erratic floridae complex of Atlantic American pipefishes.—Earl S. Herald.

Interspecies competition in natural situations.—Nelson G. Hairston.

Isolation mechanisms, speciation, and polymorphism in the viviparous Poeciliidae.—Caryl P. Haskins. (Read by Clark Hubbs)

Isolation mechanisms in anurans.—Albert P. Blair.

A short business meeting of the Texas Herpetological Society followed the symposium. Officers elected were: President, W. FRANK BLAIR; Vice-president, WERNER H. GOTTSCH; Executive Committee, JESSE C. HAVER and OTTYS SANDERS; Secretary-treasurer, HAGUE L. LINDSAY.

From 8:00 to 10:00 P.M. open house was held in the Biological Laboratories Building with the following activities available:

Texas Herpetological Society exhibit of live amphibians and reptiles.—John W. Forsyth, in charge.

Paleontological exhibit.—John A. Wilson, in charge.

Colored slides of Texas amphibian and reptiles.—Louis W. Ramsey and John W. Forsyth, Texas Herpetological Society.

Tape recordings of Texas amphibian calls.—John Wottring, Texas Herpetological Society.

Demonstrations of many species of living and preserved Texas fishes.—Clark Hubbs, in charge.

Several herpetologists took advantage of a torrential rain to make night studies of the local amphibian fauna, guided by W. FRANK BLAIR, ROBERT M. IGLEHART and DAVID L. JAMESON.

ACTIVITIES OF APRIL 12

Field trips were the order of the day. From 8:00 A.M. to 1:00 P.M. the following guided activities were listed:

Ichthyological trips: Collecting in San Marcos River, near the city of San Marcos with CLARK HUBBS in charge. Submarine theater and glass bottom boat on Spring Lake, city of San Marcos, followed by fish collecting in San Marcos River with L. V. GUERRA in charge.

Herpetological trips: Submarine theater and glass bottom boat on Spring Lake, city of San Marcos, followed by observation and collecting of *Eurycea nana*, at Spring Lake and a visit to Ezell's Cave, habitat of *Typhlomolge rathbuni* with D. L. JAMESON and W. A. THORNTON in charge. Observe and collect *Eurycea nana* at Spring Lake and general collecting on Edwards Plateau near San Marcos with C. S. SMITH in charge.

At 1:00 P.M. a most enjoyable fish fry was served at the San Marcos Laboratory of the Texas Game and Fish Commission with MARION TOOLE and

K. C. JURGENS in charge. The menu was as follows: Entree, various species of fish, including *Lepisosteus productus*, *Ictiobus bubalus*, *Carpiodes carpio*, *Cyprinus carpio*, *Pilodictus olivaris*, *Ictalurus punctatus* and *Ictalurus furcatus*, barbecued armadillo, *Dasypus novemcinctus*, and fried diamond back rattlesnake, *Crotalus atrox*, with hushpuppies, coleslaw, pickles and river coffee.

Beginning at 2:30 P.M. the following field trips were held: Ichthyological trips: submarine theater and glass bottom boat on Spring Lake, city of San Marcos with J. R. TAMSITT in charge. Collecting trip to Pedernales River at Hamilton Pool with CLARK HUBBS in charge. Herpetological trips: General collecting on Edwards Plateau about 7 miles from San Marcos with C. S. SMITH in charge. Trip to Fern Bank Spring, type locality of *Eurycea pterophila*, with W. K. DAVIS in charge. Trip to old Marnock Ranch, type locality for *Syrrhophus marnocki*, *Eleutherodactylus latrans*, *Coleonyx brevis*, *Eumeces brevilineatus*, *Thamnophis cyrtopsis ocellata* and *Agkistrodon contortrix laticinctus*, with W. W. MILSTEAD in charge. Visit to type locality of *Eurycea neotenes* and general collecting, 5 miles north of Helotes, with R. W. AXTELL in charge.

During the evening, movies of Texas amphibians and reptiles were shown in the Biological Laboratories Building by WERNER H. GOTTSCH, Texas Herpetological Society.

ACTIVITIES OF APRIL 13

The annual business meeting was held in the Experimental Science Building and called to order at 8:30 A.M. by CARL L. HUBBS in the absence of VICE-PRESIDENT MOORE who later assumed the chair. The minutes of the last meeting were adopted as published in COPEIA, 1951 (4): 320–22. The Secretary reported that 96 new members had been obtained since the last meeting and that 9 were reinstated for a total gain of 105. During the same period 5 members resigned and 16 were dropped for non-payment of dues, for a total loss of 21. The net gain of members was 84, making total membership at 1002, of which 46 are fully paid and 12 partly paid life members. The Society gained 19 new subscribers and reinstated 1, for a total of 20. One subscriber dropped, giving a net gain of 19. The total subscription list numbers 279 (not including exchanges or gifts). Geographic tabulations indicate that 220 copies of COPEIA go to 44 foreign countries. Canada leads with 50, followed by U. S. S. R. with 19, and England with 16. Domestic copies total 1104 and go to all states. California leads with 157; followed by New York with 117, Michigan 70, Texas 58, Pennsylvania 54 and Illinois 51. In 1952, 1900 copies of COPEIA will be printed, an increase of 200 over 1951.

The following gives a picture of the growth of the Society over the past ten years.

Date	Members	Subscribers	Totals
March 31, 1942.....	545	150	695
March 31, 1946.....	695	185	880
August 31, 1947.....	824	219	1043
March 31, 1948.....	887	232	1119
June 19, 1949.....	919	269	1188
June 19, 1950.....	901	272	1173
June 29, 1951.....	924	271	1195
April 9, 1952.....	1002	279	1281

The report of the Publications Secretary, N. B. GREEN was accepted as read by the Secretary (see above under Governors' meeting) and a hearty vote of thanks was given in appreciation of a job well done.

The report of the Treasurer was read by the Secretary as follows:

Financial Report for Calendar Year 1951

By D. A. Webster, Treasurer

RECEIPTS

Dues received		
Current dues for 1951 at $4.50 or $5.00	$2792.75	
Back dues for 1950 and before.....	46.50	
Advance dues for 1952 and beyond...	1537.40	$4376.65
Subscriptions received		
Current subscriptions for 1951.....	614.25	
Back subscriptions for 1950 and before.....	5.00	
Advance subscriptions for 1952 and beyond.....	1019.32	1638.57
Reprints paid for, a reimbursement of bills previously paid.....		1593.67
Back numbers of COPEIA sold.....		1870.37
Miscellaneous receipts.....		31.89
Contributions		
ROGER CONANT (toward future color plate, COPEIA).....	100.00	
CARL HUBBS (prizes, Ich. papers, West. Div., 1951).....	40.00	
L. M. KLAUBER (prizes, Herp. papers, West. Div., 1951).....	40.00	
Anonymous (to Zoological Record)...	28.03	
From members (towards publication of COPEIA).....	70.00	278.03
Interest of F. H. Stoye Fund (to be used for prizes).....		75.00
		$9864.18

EXPENDITURES

Cost of publication of COPEIA		
COPEIA, 1950, No. 4.....	$1381.75	
COPEIA, 1951, No. 1.....	2181.74	
COPEIA, 1951, No. 2.....	1340.??	
COPEIA, 1951, No. 3.....	1163.08	6066.84

Reprint costs of COPEIA (will be returned to Society)		
COPEIA, 1949, No. 3	214.94	
COPEIA, 1949, No. 4	254.27	
COPEIA, 1950, No. 1	470.19	
COPEIA, 1950, No. 2	304.99	
COPEIA, 1950, No. 3	257.44	1501.83
Republication, old series of COPEIA		529.04
Printing		123.24
Stenographic service		
Secretary	214.00	
Publications Secretary	36.00	250.00
Postage		
Secretary (Ithaca)	93.00	
Editors (Ann Arbor)	50.00	
Secretary (Western Division)	15.00	158.00
Annual meeting in Chicago		
Expenses of Secretary		125.30
Prizes awarded at Annual and Western Division Meeting		
DONN E. ROSEN	25.00	
E. H. MCCONKEY	25.00	
J. A. PETERS	25.00	
A. B. RECHNITZER	25.00	
K. S. NORRIS	25.00	
GORDON POND	15.00	140.00
Contributions		
Remittance of 50 pounds to Zoological Society of London to assist in publication of 1949 "Zoological Record"		141.53
Remittance of 50 pounds to Zoological Society of London to assist in publication of 1950 "Zoological Record"		140.13
Dues		
American Institute of Biological Sciences, 1951 dues		794.00
Miscellaneous debits		7.67
Total expenditures and disbursements		$9977.58
Excess expenditures over receipts		113.40
		$9864.18
Balance in checking account, First National Bank, Ithaca, New York, December 31, 1951		$6380.69

The balance in the checking account in the First National Bank of Ithaca, New York, on April 9, 1952 was $7486.89. The sum of $540.77 is deposited in Huntington, West Virginia, leaving the total of cash on hand at $8027.66. The Auditing Committee reported that the Treasurer's report was in good order. Brief reports of the status of the Endowment, Revolving Research, and Frederick H. Stoye funds were given by the Secretary (see above under Governors' meeting).

EDITOR-IN-CHIEF GERALD P. COOPER reported on the change of printers to Waverly Press for 1952 and discussed changes in format, cover design, cost of reprints and paper costs. The Secretary was instructed to send a letter of appreciation to Ann Arbor Press thanking them for the excellent job done on COPEIA over the years. The Secretary reported on the Board of Governors meeting held on April 9. The changes in the Constitution and By-laws mentioned above were duly adopted as passed at the Board of Governors' meeting.

VICE-PRESIDENT MOORE reported that a modest membership drive was attempted during the year and that 465 letters and membership blanks were sent to members at representative institutions.

The Report of the Committee on Traffic in Venomous Snakes was read by CHARLES M. BOGERT as follows: This Committee, which was charged by PRESIDENT MYERS to look into the matter of possible legislation controlling the importation of venomous snakes, made a report at the Chicago meeting of the Society in June, 1951. In its report the Committee recommended: (1) That no measures be taken at present to control such importations; (2) that the American Society of Ichthyologists and Herpetologists should cooperate with the United States Fish and Wildlife Service, the United States Public Health Service, or any other enforcement agency if legislation should become necessary; and (3) that someone should work out a set of recommendations for future guidance.

Having "stuck its neck out" by suggesting point three, the Committee was immediately reappointed by PRESIDENT MYERS and instructed to take care of the additional chore.

Since circumstances prevailing in the future may be quite different from those prevailing at present, your Committee does not deem it advisable to itemize detailed suggestions. But there are several matters of general policy which have been mentioned by one or more members of the Committee, and these are worthy of record. In the event that the Congress should take action to control the importation of venomous snakes, it is recommended:

(1) That the enforcement agency be requested to work in close cooperation with the American Society of Ichthyologists and Herpetologists, the American Association of Zoological Parks and Aquariums, and any other organization whose members may need living venomous snakes for study or public exhibition.

(2) That safety standards be established regarding types of shipping containers.

(3) That minimum standards be established for the safe caging or exhibition of poisonous specimens.

(4) That import permits be issued to such institutions, organizations, or individuals (twenty-one years of age or older) who show proof of needing living venomous snakes; and that such permits be renewed periodically.

(5) That interstate traffic in venomous snakes be restricted to permit holders.

In making these suggestions your Committee reiterates its statements of last year: the facts at

hand indicate that no control legislation is needed at present, and it is hoped that none will be required in the future.—ROGER CONANT, Chairman, CHARLES M. BOGERT, E. R. DUNN, ROBERT H. MCCAULEY, JR. and WILLIAM H. STICKEL.

KARL P. SCHMIDT transmitted to the Secretary, his report as a Committee of One for the Check List of North American Amphibians and Reptiles. He reported the completion of the manuscript except for the one item of consultation with colleagues as to common names, and he expects it to be ready for press by June 1, 1952. The Society confirmed the original proposal that the sixth edition of the Check List be printed and distributed by the Society and empowered the appointment of a small committee to get estimates of costs and to proceed with publication.

CLIFFORD H. POPE, chairman of the Nominating Committee (other members: ALBERT W. HERRE, CARL L. HUBBS, M. GRAHAM NETTING and HOBART M. SMITH), reported that the officers as listed on the inside of the back cover of this issue of COPEIA had been duly elected by mail ballot. The Secretary was directed to bring before the next meeting of the Board of Governors for discussion the proposition that the offices of president and vice-presidents have at least two nominees at future elections.

DR. CLARENCE J. HYLANDER, the Executive Secretary of the American Institute of Biological Sciences, addressed the meeting on the activities of that organization and was available during two days of the meeting for consultation with members of the Society.

The business meeting adjourned at 10:15 A.M.

Two concurrent sessions were held during the remainder of the morning. VICE-PRESIDENT MOORE presided at the ichthyological session and the following papers were read:

The taxonomic status of Opsanus tau and O. beta.—F. T. Knapp and R. W. Menzel.

Oodinium ocellatum, a lethal dinoflagellate gill parasite affecting Hawaiian and Californian fishes.—Robert P. Dempster.

History of the use of garfish scales in arts and crafts.—Percy Viosca, Jr.

A classification of the American percid fishes.—Reeve M. Bailey.

Observations on breeding Poecilichthys lepidus and Microperca fonticola in aquaria.—Kirk Strawn.

Dynamics of marine fishery populations.—Martin D. Burkenroad.

CLIFFORD H. POPE served as chairman for the herpetological sessions where the following papers were read:

Plethodon cinereus and the forms of the small flecked plethodons in the Appalachian Mountains.—Arnold B. Grobman.

Linkage of color pattern with morphological characters in Eleutherodactylus podociferus.—Edward H. Taylor.

The ratsnakes (genus Elaphe Fitzinger) of Mexico and Central America.—Herndon G. Dowling.

Geographic variation in Thamnophis cyrtopsis.—W. W. Milstead.

A study of geographic variation in the green frog, Rana clamitans Latreille.—John S. Mecham.

Preliminary review of the lizards of the genus Emoia with notes on their distribution.—Walter C. Brown.

The identity of the Black Hills population of Opheodrys vernalis.—C. Richard Robins and Arnold B. Grobman.

A taxonomic study of the western fence lizard, Sceloporus occidentalis.—Edwin L. Bell.

A new fossil frog from the Pleistocene deposits of Texas.—Hague L. Lindsay.

At 2:30 P.M. a joint session heard a report by the chairman of the Committee on Zoological Nomenclature, W. I. FOLLETT. The report was accepted and the chairman was instructed, after consulting further with the members of his committee, to convey his recommendations to the Secretary of the International Commission of Zoological Nomenclature. Other members of this Committee are C. M. BOGERT, A. B. GROBMAN, R. R. MILLER H. M. SMITH and N. J. WILIMOVSKY.

Split sessions were again held beginning at 3:00 P.M. ROBERT R. MILLER presided at the ichthyological sessions where the following papers were read:

Certain factors related to populations of marine fishes of the Gulf Coast.—Gordon Gunter.

Distributional problems in freshwater fishes of New York.—Edward C. Raney.

Experimental rotenone treatment of the Guadalupe River.—Robert A. Kuehne.

The George Vanderbilt Pacific Equatorial Expedition of 1951.—Earl S. Herald and Robert R. Harry.

No formal meeting of the Committee on Fish Classification was held. However, CARL L. HUBBS commented briefly on Circular 5 which was made available to the members of the Committee present. It consists of a manuscript "The Classification of Iniomous Fishes" by Robert R. Harry. The membership of this committee is G. S. MYERS, chairman, R. M. BAILEY, R. L. BOLIN, R. H. DENNISON, D. H. DUNKLE, C. L. HUBBS, A. E. PARR, E. C. RANEY, BOBB SCHAEFFER, L. P. SCHULTZ and JOHN TEE-VAN.

The chairman of the Committee on Common Names of Fishes, REEVE M. BAILEY, presented a short report outlining the problems under study at present. The membership of this committee (identical with the same committee of the American Fisheries Society) is R. M. BAILEY, F. T. KNAPP, E. A. LACHNER, E. C. RANEY, G. S. MYERS, W. E. RICKER and J. C. MARR.

The herpetological session held at 3:00 P.M. was presided over by NORMAN E. HARTWEG and the following papers were read:

The geographic variation of the blacksnake, Coluber constrictor, in Florida.—Walter Auffenberg.

Outline for study of salamander life histories.—Robert C. Stebbins.

Population relations and isolation mechanisms in Bufo woodhousii and B. valliceps.—Wilmot A. Thornton.

Home ranges and movements of various reptiles in northeastern Kansas.—Henry S. Fitch.

Round table discussion: The why and how of population dynamics studies.—W. Frank Blair, Coleman J. Goin, Henry S. Fitch and Robert C. Stebbins.

A recently made moving picture showing "Functioning of the loreal pit in the rattlesnake" was presented by RAYMOND B. COWLES.

From 7:00 to 9:00 P.M. nearly 200 members and guests were feted at a Texas-style barbecue arranged by MARION TOOLE. The sumptious repast was followed by special entertainment by a well known Texas trio. The winners of the Frederick H. Stoye awards were announced. First prize in ichthyology of $25 went to KIRK STRAWN. First prize in herpetology was awarded to JOHN S. MECHAM and second prize of $15 went to PAUL S. MARTIN. The following report was then offered by the Committee on Resolutions:

Whereas, the thirty-second annual meeting of the American Society of Ichthyologists and Herpetologists, held at the University of Texas in Austin from April 10 through 13, 1952, has been successfully completed;

Therefore, be it resolved: (1) That the members of the Society express their appreciation for the unlimited courtesy and hospitality extended to them by the *Local Committee:* W. FRANK BLAIR (Chairman), and members RALPH W. AXTELL, M. J. FOUQUETTE, CLARK HUBBS, DAVID L. JAMESON, KENNETH C. JURGENS, GEORGE KRISE, HAGUE L. LINDSAY, WILLIAM W. MILSTEAD, KIRK STRAWN, WILMOT A. THORNTON, MARION TOOLE, and the wives of same, as well as their other assistants.

(2) That W. FRANK BLAIR as Chairman of the Program Committee be thanked for his success in arranging a splendid program of scientific papers.

(3) That we owe special thanks to the officials of the University of Texas for their hospitality and for the use of many of their facilities.

(4) That we owe great thanks to the Texas Herpetological Society and others for providing a splendid exhibit of living and preserved fishes, amphibians, reptiles and fossils.

(5) In addition to members of the Local Committee, L. V. GUERRA, C. SPURGEON SMITH and JIMMY R. TAMSITT should be thanked for their part in guiding local trips, and THOMAS E. KENNERLY, HOMER W. PHILLIPS, JACK A. HERRMANN, WERNER H. GOTTSCH, BILLY D. COOPER and BILL PYBURN be thanked for transportation and other services.

(6) That we are appreciative of the program planned by the Local Committee for the entertainment of wives and friends of members.

Whereas, EDWARD C. RANEY has submitted his resignation as Secretary of the American Society of Ichthyologists and Herpetologists, having served faithfully and with outstanding competence;

Therefore be it resolved: (1) that the Society regretfully accept his resignation and (2) that the Society express its sincere appreciation for this long and splendid service.

Whereas: The Society has lost by death a valued member in science and an important investigator in SHERMAN C. BISHOP;

Therefore be it resolved: that the Society, cognizant of this loss, request the Secretary to convey to MRS. BISHOP and family the sincere sympathy of the Society.

A total of 126 members and 115 non-members registered during the sessions. This was the best attended meeting of the Society in the Secretary's experience. Fifty-nine persons registered with the Texas Herpetological Society.

ACTIVITIES OF APRIL 14

Approximately 30 members traveled by automobile to Rockport where they were guests of the Texas Game and Fish Commission with J. L. BAUGHMAN, Director of the Rockport Marine Laboratory, in charge. The party went aboard two shrimp trawlers and observed many fishes and invertebrates that were captured in the bay off Rockport.

In the evening the members of the Society were joined by the staff of the Laboratory in a shrimp boil that will long be remembered by all those present. Several movies in color were shown of research activities of the laboratory with running comments by J. L. BAUGHMAN.—EDWARD C. RANEY, *Retiring Secretary.*

Meeting of Western Division The 21st annual meeting of the ASIH, Western Division, was held on June 17–18 at Oregon State College in Corvallis, as part of the annual meeting of the Pacific Division of the AAAS.

In ichthyology, there was a symposium on "Fish and Dams—Recent Developments in the Pacific Northwest" and a half-day of submitted papers. In herpetology, there was a symposium on "Methods of Field Study in Herpetology" and one submitted paper.

Student awards, in ichthyology were: *first*, to ANDREAS B. RECHNITZER, Scripps Institution of Oceanography, La Jolla, California, for a paper on "Systematic Serology and its Relation to Ichthyology"; *second*, divided between two contestants, CONRAD LIMBAUGH, Scripps Institution of Oceanography, La Jolla, California, for a paper on "Life History Notes on the Garibaldi (*Hypsypops rubicunda*), a California Pomacentrid," and RICHARD E. NOBLE, Zoology Department, Oregon State Col-

lege, Corvallis, Oregon, for a paper on "Apparent Relationship of Water Temperatures to Young King Salmon Distribution as Observed on the Willamette River System during the Summer of 1951."

There were no student papers in herpetology.

New officers elected by the Western Division are listed on the inside back cover of this issue of COPEIA.

Sociedad Mexicana de Hidrobiología DR. JOSÉ ALVAREZ DEL VILLAR, Secretary of this new society (address: Aparatado Postal 30491, México, D. F., México), recently wrote to GEORGE S. MYERS as follows:

"We are pleased to announce to the members of the American Society of Ichthyologists and Herpetologists that, as of November 30, 1951, the *Sociedad Mexicana de Hidrobiologia* was founded by a group of Mexican workers in the different fields connected with hydrobiology.

"The aim of this society is to foster all activities related to this branch of Science and establish closer contact among the various workers in this field, in the country and abroad. This society will be a link between Mexican workers and foreign institutions, for the benefit of both. We have no journal of our own, but occasional publications will be printed, and papers submitted to the SMH will be published in the various Mexican scientific journals.

"Session will be held once a year, and will be in the nature of a meeting, to last as long as may be considered necessary for the presentation of all contributions.

"Foreign workers are invited to join as ordinary members, at an annual fee of $15.00 Mexican currency (approximately $1.75 U. S.)."

Financial contributions Voluntary contributions toward publication of COPEIA for 1952 have been made by the following: SARAH R. ATSATT, HERBERT BARDEN, GERALD DEBARRY, GEORGE A. CROGAN, T. K. ELLIS, W. I. FOLLETT, JESSE HAVER, JOHN R. HORNBROOK, JR., THOMAS H. LEWIS, GEORGE P. MEADE, R. G. MILLER, W. M. MORTON, J. C. ORTH and J. D. RUICK. MAJOR CHAPMAN GRANT has made a financial contribution toward the cost of publication of the plate illustrating his article in this issue. The American Museum of Natural History has contributed toward the cost of the collotype plate in the article by C. M. BREDER, JR. in COPEIA, 1952 (2): 90–91.

Revolving research fund According to the By-laws, the Revolving Research Fund is available for small grants to younger members for assistance in research. There is no obligation to repay these grants, but it is expected that recipients will contribute a like or greater sum to the fund when professionally established and able to do so. At the meetings of the Board of Governors in Austin, Texas, further motion was passed that, aside from the use specifically provided for in the By-laws, grants from the fund might be used by young members of the society for the purchase of reprints of papers published in COPEIA or other journals.

A new Journal *Systematic Zoology*, the quarterly journal of the Society of Systematic Zoology, was inaugurated in March, 1952, with a 48-page issue. Contributions on the basic aspects of all fields of systematics are welcome, and the journal is to serve also as a forum for discussion of the problems and methods of the systematist and to report news of the activities of the Society and of its members. Subscription rates are $4.00 to members, $7.00 to non-members and institutions; single numbers (when available) are $1.50 to members and $2.00 to non-members. DR. R. E. BLACKWELDER, Room 429, U. S. National Museum, Washington 25, D. C., Secretary-Treasurer of the Society, is serving as Editor, *pro tem*.

Committee on common names A new standing *Committee on Common Names of Fishes* of the American Society of Ichthyologists and Herpetologists was established in March of this year by PRESIDENT GEORGE S. MYERS. This committee shares the objectives and functions of the Committee on Names of Fishes of the American Fisheries Society. In order to assure uniformity the membership of the two committees is the same, all persons being members of both societies: REEVE M. BAILEY (Chairman), FRANK T. KNAPP, ERNEST A. LACHNER, JOHN C. MARR, GEORGE S. MYERS, EDWARD C. RANEY and WILLIAM E. RICKER. Since both organizations, with their respective publications, will adopt the same vernacular names, it is anticipated that this move will aid materially in stabilization of nomenclature. Copies of "A List of Common and Scientific Names of the Better Known Fishes of the United States and Canada" (1948, Amer. Fish. Soc., Special Publ. 1: 1–45) may be obtained for 25 cents per copy from DR. WILLIAM C. BECKMAN, Librarian, American Fisheries Society, Colorado Cooperative Fisheries Research Unit, Colorado A. and M. College, Fort Collins, Colorado.

News notes JAMES NELSON GOWANLOCH, for 22 years Chief Biologist, Bureau of Scientific Research, Louisiana Department of Conservation, died on May 28, 1952, at the age of 56.

The Division of Fishes, U. S. National Museum has had assigned to it an additional storage room.

As soon as steel shelves are installed, all unworked specimens will be removed from the present storage and placed in the new room. This will make available needed shelves for an arrangement of the overcrowded families. Small, monel, metal-lined tanks, 30 x 32 x 24 inches, are being built to replace the earthenware crocks. This project when completed will increase the present storage capacity for moderate-sized specimens by ¼ or about 1,500 gallons, replacing 600 crocks. At the present time, there are in use 15,765 feet of steel shelves.

Dr. E. A. LACHNER and WILLIAM T. LEAPLEY, of the U. S. National Museum, left on April 1, for a 4-week collecting trip through the south central states.

DR. W. A. GOSLINE, University of Hawaii, has been awarded a research contract by the Biology Branch, Biological Sciences Division, of the Office of Naval Research, to study "The Nature of the Fish Faunas of the Southern Marshall and Gilbert Islands."

All amateur and professional ichthyologists and herpetologists from the southeastern region (Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Tennessee, Kentucky, District of Columbia) are invited to attend and participate in the second annual meeting of the Southeastern Herpetological Society presently planned for October 24–25 at the University of Alabama, Tuscaloosa. Plans for a permanent organization and the proposed affiliation with the ASIH will be discussed at the business session. DR. RALPH CHERMOCK, Department of Zoology, University of Alabama, is Chairman of the Local Committee in Charge of Arrangements, and anyone wishing to present a paper at the meetings should notify him on or before October 10. (Please include title of paper, time needed and projection equipment needed.) To those writing to DR. CHERMOCK indicating interest in the meetings, an announcement listing details of housing, and the program will be mailed about a week prior to the sessions.

In COPEIA, 1952, No. 2, on page 72, right-hand column, 13th line from the top, delete the word "until."

American Society of Ichthyologists and Herpetologists

BOARD OF GOVERNORS

Officers, including those of the Western Division, are exofficio members of the Board of Governors. Former presidents are members of the Board for life.

ELECTIVE MEMBERS

Terms expire in 1953	*Terms expire in 1954*	*Terms expire in 1955*
BAILEY, JOSEPH R.	BOLIN, ROLF L.	BAUGHMAN, J. L.
CONANT, ROGER	HARDY, ROSS	CARR, A. F., JR.
COWLES, RAYMOND B.	CLARK, FRANCES N.	ESCHMEYER, PAUL H.
GORDON, MYRON	GLOYD, H. K.	FITCH, HENRY S.
GOSLINE, WILLIAM A., III	JOHNSON, RAYMOND E.	HERALD, EARL S.
HAMILTON, W. J., JR.	LACHNER, ERNEST A.	MARR, JOHN C.
HARTWEG, NORMAN E.	NECKER, WALTER L.	MOORE, GEORGE A.
SCHROEDER, WILLIAM C.	RIVAS, LUIS R.	NEEDHAM, PAUL R.
TAYLOR, E. H.	STOREY, MARGARET	STEBBINS, ROBERT C.
TRAUTMAN, MILTON B.	VIOSCA, PERCY, JR.	WALKER, BOYD W.

Terms expire in 1956	*Terms expire in 1957*
BLAIR, W. FRANK	BAILEY, REEVE M.
CARLANDER, KENNETH D.	CAGLE, FRED R.
HUBBS, CLARK	DAVIS, D. DWIGHT
INGER, ROBERT F.	OLIVER, JAMES A.
RICHMOND, NEIL D.	RANEY, EDWARD C.
SCOTT, DONALD M.	RIGGS, CARL D.
SEAMAN, E. A.	SMITH, HOBART M.
SNYDER, RICHARD C.	SUTTKUS, ROYAL D.
STOYE, FRED H.	TIHEN, JOE A.
WEISEL, GEORGE F.	WOODS, LOREN P.

COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

Officers

Honorary Presidents—JOHN TREADWELL NICHOLS (Ichthyology), American Museum of Natural History, New York 24, New York; HELEN T. GAIGE (Herpetology), 1211 Ferdon Road, Ann Arbor, Michigan.

President—CHARLES M. BOGERT, American Museum of Natural History, New York 24, New York.

Vice-Presidents—(Conservation) JOHN TEE-VAN, New York Zoological Society, New York, New York; (Finance) GEORGE P. MEADE, Colonial Sugars Company, Gramercy, Louisiana; (Membership) GEORGE A. MOORE, Department of Zoology, A. and M. College of Oklahoma, Stillwater, Oklahoma.

Treasurer—COLEMAN J. GOIN, Department of Biology, University of Florida, Gainesville, Florida.

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